NGU Report 2006.061

Geolaboratory benchmarking, 2005/2006

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REPORT

Report no.: 2006.061	ISSN 0800-3416	Grading: Confidential until 31.12.2011

Title:
Geolaboratory benchmarking, 2005/2006

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County:	Commune:
Map-sheet name (M=1:250.000)	Map-sheet no. and -name (M=1:50.000)
Deposit name and grid-reference:	Number of pages: 147 Price (NOK): Map enclosures:

Fieldwork carried out:	Date of report:	Project no.:	Person responsible:
2005/2006	February 12th 2007	308200	Øystein Nordgulen (signature)

Summary:

In 2005 the geological surveys of Norway (NGU), Finland (GTK) and Great Britain (BGS) took part in a joint benchmarking exercise to compare practices, performance, strategies etc. at the survey laboratories. The ultimate purpose of the exercise was to provide a benchmark for improving laboratory performance, and help each laboratory and its parent survey prepare for up-coming strategic challenges.

The laboratories are different on scales: NGU has the smallest laboratory operated at 19 manpower years (MPY) and GTK the largest with 115 MPY. The BGS laboratories employ 44 MPY. The survey laboratories also have very differing strategies with regards to commercial operation. Where the NGU laboratories bill 95 % of the data production internally, the internal services at the GTK and BGS laboratories accounts for only 50 and 35 % respectively. In terms of relative spending in administration and production, R&D, level of investments, earnings, applications and equipment, as well as future expectations the laboratories are with few exceptions remarkably analogous. The BGS and GTK laboratories carry a somewhat wider portfolio than the smaller NGU-Lab, and in particular GTK has a high throughput of analyses of extracts and digests, more than 20 times that of NGU and BGS. All three laboratories are accredited according to EN-17025 for the majority of their methods.

This report presents a compilation of data from both a range of individual laboratory services as well as the geosurvey laboratories and their host institutions in general. Scoreboards and detailed performance critics are not included this report. Conclusions based on this exercise are intended to be drawn by each institution internally.

Keywords:	Laboratory	Benchmarking

CONTENT

1. INTRODUCTION

In 2005 the Geological Survey of Norway initiated a project, internally labelled 308200: evaluation of NGU-Lab, of which the goal was to evaluate analytical practices, investment and personnel strategies as well as performance of the NGU laboratory in cooperation with other geosurvey laboratories. The Finnish and British geological surveys were then contacted and subsequently consented to establish such cooperation for their own benefit as well. A meeting was held at NGU in Trondheim in September 2005 and the outline of the exercise established. All reporting was to be considered confidential among the three surveys until otherwise agreed, and due to the varying price policies actual price of services was not an issue in the distributed pro formas. Otherwise the discussions were open and all meetings conducted in a very un-secretive spirit. Data collection took place through winter and early spring of 2006 with meetings at BGS in late November and GTK in January.

2. DATA COLLECTION

Two pro formas were distributed among the three laboratories. A few adjustments were required during the data collection and the pro formas are presented in their final form in figs 1 and 2. The first pro forma (fig. 1) was intended to record data such as the laboratory size in terms of manpower years (MPY). It also recorded the staff profiles, overall laboratory economy and given economic frames, and details about the quality systems. In addition a detailed portfolio was requested.

The second pro forma (fig. 2) recorded data concerning the specific activities under scrutiny. The list of targeted activities was set up in mutual agreement to cover most of the common services of significant volume. Still, certain activities are performed on different scales or on very different sample volumes, or with very differing applications, which makes the comparison less instructive and quantitative. For a few activities only two of the three laboratories have submitted data. The services investigated are:

1. Analysis of water
   including both natural and contaminated waters
2. Analysis of acid extracts
   presented as either total digestion or partial extracts
3. Geological material by XRF
4. Geological material by XRD
5. SEM/EPMA
6. LA-ICP-MS
7. Thin section preparation
8. Grain size distribution
9. Mineral separation

In addition both BGS and NGU submitted data for the analysis of carbon and sulphur in solids, which have thus been included in the dataset. The detailed pro forma was intended to record instrumentation and methodology, plans for investments and accreditation, sample volumes, economy and man power use, as well as customer type (internal/commissioned work).

Pro forma general data

Laboratory at Institution:

Laboratory staff	*Number*	*Average salary*	**Survey staff**	
Staff profile: PhD			*No of PhD*	
MSc or equivalent				
Technical staff				
Total staff at lab.			*Total staff at survey*	

Laboratory expenditures (years and €/yr)	Man p. years	Staff costs	Direct expences
Laboratory total exp.			
Investments			
R&D			
Production			
Consumables			
Service contracts			
Subcontracts			
Administration			
Management			
Quality management			
LIMS			
*In-house administrative services**			
Total labour costs			
Salaries			
*Overhead***			

Total turnover at institution (M€/yr)

Laboratory earnings (€/yr) *External:* *Internal:*

Cost of premises (€)***

Quality system

Frequency of external audits (specify)	
Frequency of internal audits (specify)	
Customer satisfaction: method of assessment, last date or frequency of questionnaires etc. etc.	

*) The figure comes in addition to the (total) regular laboratory administration costs further up. It can probably only be estimated.

**) Salaries refer to money actually paid out. Overhead here should include both social costs (pensions and other benefits) as well as premises, in-house services etc. etc.

***) premises should be calculated as the average rent, heat, electricity, water etc. per area multiplied by the total laboratory area. The figure makes up part of the salary overhead.

Fig. 1. General pro forma to cover laboratory economy, quality system and man power use.

Pro Forma, activity

Activity:

Instrumentation, including age, model and make:

Brief description of method and applications (include comment on level of R&D vs. production):

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C):

Is the activity wholly or partly accredited?:

Comment if yes:

Participation in proficiency testing – number of tests per year for activity:

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:			
Income received per year (€):			

Sample volume in % of total volume at laboratory:

Instrument utilisation (hours per year):

Theoretical max. utilisation:

Man power years on activity:

Staff costs on activity (€):

Expenses on service contracts in €/yr:

Direct costs of activity €/yr (excluding service contracts):

Fig. 2. Detailed pro forma to cover methodology, economy, expectations, sample volume and customer type for specific activities.

3. THE SURVEYS

The laboratories under investigation belong to three national geological surveys, and as such likely to be comparable both in focus and structure. The surveys, NGU, GTK and BGS, can probably all be considered national institutions of knowledge on rocks, sediments soils, mineral resources and water, and their laboratories expected to deliver accordingly. The main difference between the surveys seems to be in their size.

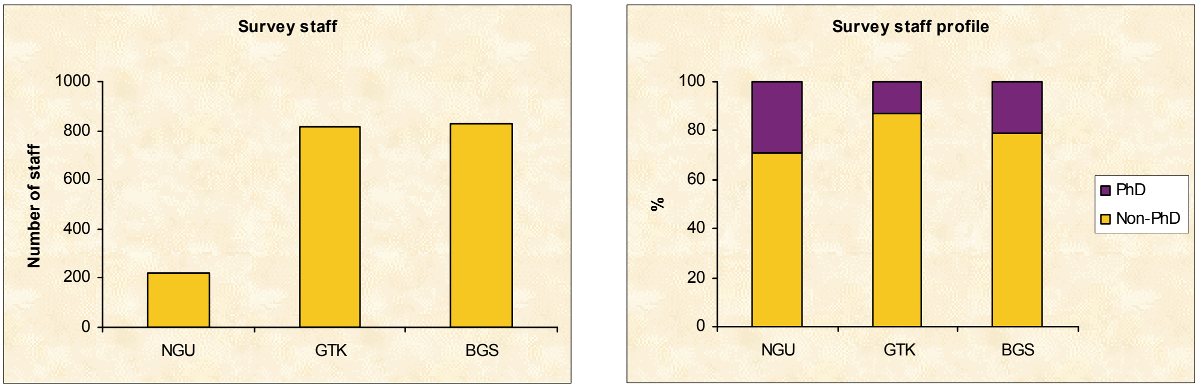


Fig. 3. Number of staff at the three geosurveys, NGU, GTK and BGS (left). Survey staff profile, with regards to number of PhD level employees (right). Figures are actual number of staff rather than MPY.

The three geosurveys have markedly different sizes with both GTK and BGS being more than 3 times as big as NGU (Fig. 3). BGS has a staff of 827 (785 MPY), GTK of 815 (780 MPY), and NGU employs a staff of 220 (200 MPY). Considering the number of PhD-level employees at the surveys, the formal competence profiles are reasonably comparable: 29 % of the staff at NGU have PhDs, GTK has 13 % PhD-level employees and BGS 21 %.

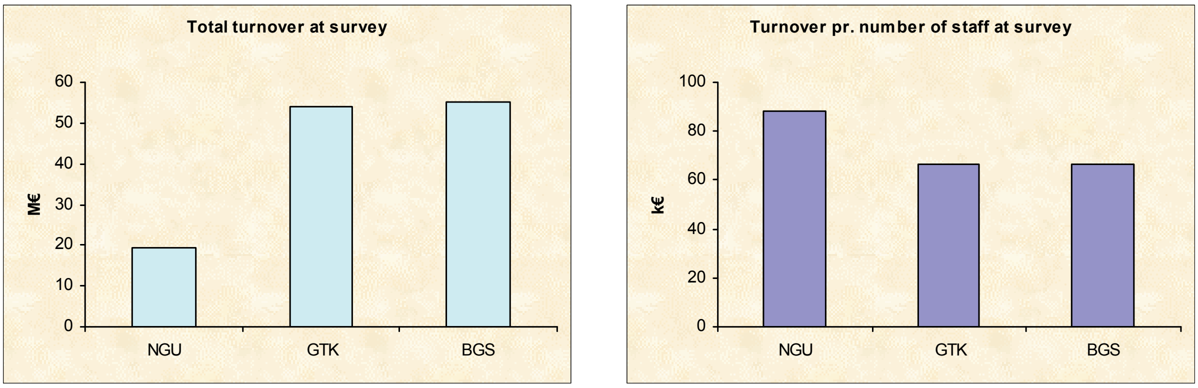


Fig. 4. Survey economy in terms of yearly (2005) turnover in million € (left) and turnover per number of staff (right).

As is shown in Fig. 4, the total turnover at NGU is much smaller than at GTK and BGS, even though the difference is less marked than for the number of staff (Fig. 3). Total turnover at NGU (2005) was € 19.4 mill., whereas GTK and BGS had turnovers of € 54.0 and 55.1 mill. respectively. If the total turnover is normalised with respect to the number of staff (Fig. 4), the turnover is highest at NGU (€ 88,200), and smaller at BGS (€ 66,600) and GTK (€ 66,300).

4. THE LABORATORIES

NGU-Lab. The laboratory at the Norwegian Geological Survey has a staff of 21 dedicated mainly to inorganic analysis of rocks, minerals, soils and water. Various preparates of rocks, soils, microfossils and pollen etc., as well as petrophysical and mechanical testing, also form an important part of the laboratory activities. Organic analyses are not included in the laboratory portfolio. Most routine analyses are accredited according to NS-EN-17025 and have been since 1994. NGU-Lab responds positively to analytical requests from external clients, but is by statute not allowed to compete with commercial operators (NGU-Lab thus cannot bid for tenders etc.). The result is that between 90 and 95 % of the NGU-lab services are to internal (i.e. NGU) customers. Billed services amounts to around € 1.5 mill. per year.

BGS-Lab. The principal part of the laboratory services of the British Geological Survey is located with the parent institution in Nottingham. The services include the full range of inorganic analyses along with analyses of organic pollutants and radioactivity. The laboratories are accredited according to EN-17025 and ISO 9001, and partly also to the British UKAS accreditation system. The BGS laboratories have a staff of 85. The yearly earnings is on the order of € 3.2 mill. of which almost € 2 mill. derive from external clients.

GTK-Lab. The laboratory division at the Finnish Geological Survey is divided into five different units located around the country. Two laboratories are located in Espoo, and the other three in Rovaniemi, Outokumpo and Kuopio. The facility in Rovaniemi mainly targets the Finnish mining and exploration industry, whereas the laboratory in Kuopio is dedicated more towards environmental services. The laboratory in Outokumpo is concerned with larger scale mineral technology and is not considered part of the current study. The "Geolaboratory" and the "Research laboratory" of the GTK are both located with their parent institution in Espoo. Most services are accredited according to EN-17025. A total staff of 94 is affiliated with the four laboratories included in the exercise. The GTK laboratories also have a strong commercial profile accounting for around 50 % of the income, and a total yearly income from billed services of € 5.3 mill.

5. GENERAL COMPARISON

5.1 Salary costs and profiles

The prime factors controlling the total manpower salaries at the geosurvey laboratories include the price/salary levels in the various countries and the staff competence profiles. The salary level may be illustrated by plotting the salaries for certain types of employees (Fig. 5).

For all groups the salaries are higher at NGU than at the other institutions. BGS has the lowest salaries except for non-university staff, which have lower salaries in Finland. For PhD level employees NGU salaries are on average 11 % higher than GTK salaries and 28 % higher than BGS salaries. The differences increase for employees with lower formal competence, where NGU employees receive salaries 84 and 42 % higher than GTK and BGS employees respectively.

At GTK the average difference in salary between a person with a PhD and a person without a university degree is a factor 2.3. The difference is less at BGS (1.6) and smallest at NGU (1.4).

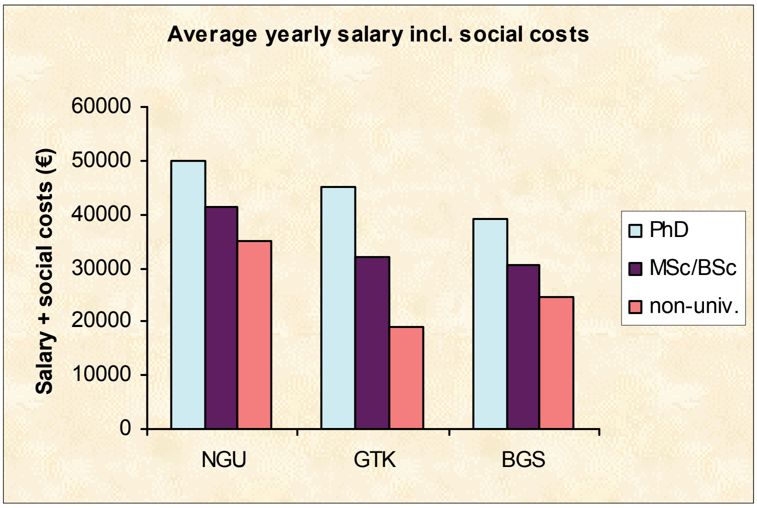


Fig. 5. Average salaries for different levels of formal competence at BGS, GTK and NGU

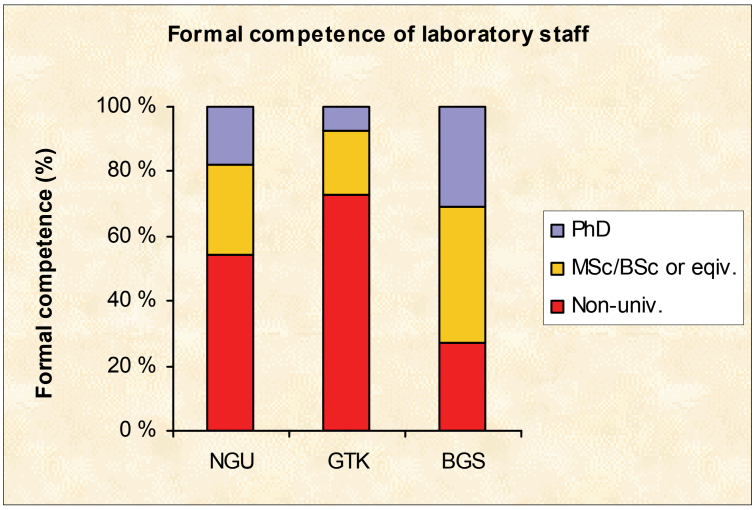


Fig. 6. Formal competence of staff employed at the survey laboratories.

The formal competence profiles are illustrated in Fig. 6. BGS has the highest number of PhDs working in their laboratories and the lowest number of non-university staff. The profile possibly reflects the high degree of integration of the BGS labs in the BGS research organisation (with only 44 MPY and a total staff of 85 at the BGS laboratories). GTK has the lowest number of PhDs among the laboratory staff and the highest fraction of non-university personnel.

The disparity in salaries combined with the laboratory staff profiles leads to a net difference in the average price of manpower, where the GTK laboratories have the lowest costs. The salary costs at the BGS laboratories are 34 % higher, and at NGU-Lab the costs are 68 % higher.

Another cost determining factor outside laboratory management control is the salary overhead. The overhead is calculated in various ways in the three institutions so total cost of manpower cannot be compared directly. However, Fig. 7. displays the laboratory rental costs including services, which constitute at least a part of the salary overhead. Again there is considerable difference between the three institutions with GTK having the lowest costs per employee. The costs of premises and services at BGS are 53 % higher than at GTK, and at NGU 68 % higher than at GTK.

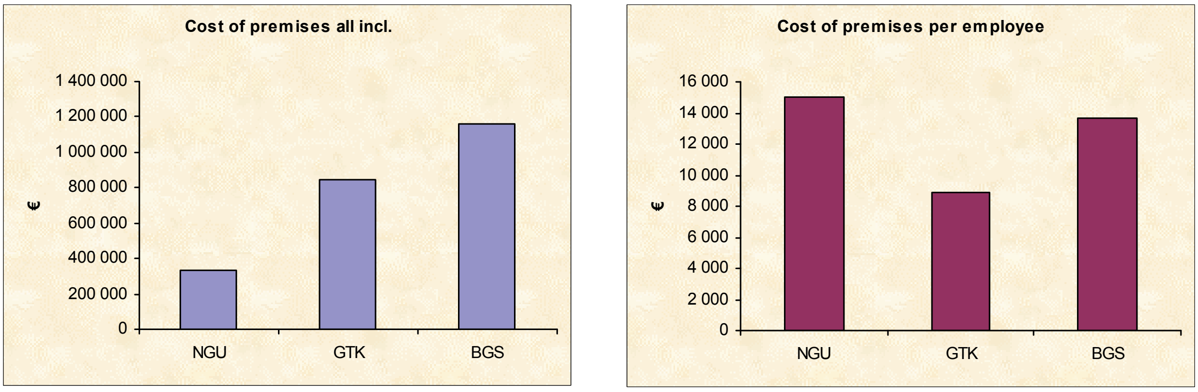


Fig. 7. Cost of premises including services (heat, electricity, cleaning etc.) in absolute numbers (left) and per employee (right) at NGU, GTK and BGS.

5.2 Portfolios

For NGU-Lab the current study does not take into account analytical services at the survey not under laboratory control; these include Ar-Ar isotope analyses, VSM (vibrating sample magnetometry), gamma ray spectrometry (field technique), and paleomagnetics. The BGS mobile lab is similarly excluded from the list (Fig. 8), and for GTK the services delivered by the Outokumpo facility (mineral technology) are ignored in the general portfolio. The service portfolio is presented in Fig. 8.

Material/Category	Method	NGU	BGS	GTK
WATER	*ICP-OES*	x	x	x
	ICP-MS	x	x	x
	GF-AAS	x		
	CV-AAS (Mercury)	x		x
	AFS (Mercury)		x	
	Ion chromatography	x	x	x
	Phosphate by colorimetry			x
	pH	x	x	x
	Alkalinity	x	x	x
	Conductivity	x		x
	Turbidity	x		
	Colour index	x		
	TC, TOC		x	
	UV absorbance (Fe(II))		x	
	SFC (total iodine and nitrogen species)		x	
SOLIDS	*XRF*	x	x	x
	XRD	x	x	x
	SEM/EPMA	x	x	x
	ICP-OES (digests/extracts)	x	x	x
	ICP-MS (digests and extracts)	x	x	x
	F-AAS-precious metals (Hg coprecipitated AR-leaches)			x
	GF-AAS (digests and extracts)	x		x
	CV-AAS-Hg (digests and extracts)	x		
	AFS-Hg (digests and extracts)		x	
	LA-ICP-MS	x	x	
	Pb fire assay for precious metals			x
	NiS fire assay for PGE			x
	TC/TOC/(TS)	x	x	x
	Total nitrogen			x
	Fluorine by fusion and potentiometry			x
	Grain size distribution (coulter/sedigraph)	x	x	
	Ph in soils ($CaCl_2$ slurry method)		x	
	Fe(II) by acid digestion and titration			x
	LoI (1000C)	x	x	x
	LoI (450-550C)	x	x	x
ORGANICS	*HPLC (PAHs)*		x	
	GCMS (PCBs)		x	
	Total petroleum hydrocarbons in sediments and soils		x	
	Determination of humus content			x
	Calorific value			x
PREPARATES	*Thin sectioning service*	x	x	x
	Mineral separation	x	x	x
	Palynology/dinoflaggelate prep.	x		
PETROPHYSICS	*Remanens, susceptibility, density*	x		
	Thermal conductivity	x		
OTHER	*Mechanical testing/rock mechanics - various methods*	x	x	x
	Gamma ray spectrometry		x	
	X-ray core inspection	x		

Fig. 8. General portfolio for GTK, BGS and NGU.

The main part of the general portfolios at the three laboratories is quite similar (fig. 8). All laboratories maintain a strong focus on XRF and plasma source analyses on rock powders, waters, acid extracts and digests. All laboratories register an increasing demand for environmental analyses. BGS and GTK being the larger laboratories have a wider portfolio compared with NGU; BGS supply a range of analyses of organic pollutants and radionucleiides not covered by the NGU portfolio, and GTK has a very large production in mining related analyses based on fire assays and digests also not covered by NGU. All laboratories have maintained a considerable production in classical geolaboratory services, such as thin section preparation and various casting/polishing services, mineral separation and standard geochemical analyses.

5.3 Size and economy

Comparing budgets, spendings, earnings and other economic parameters will inevitably be affected by the varying budget, price and charging policies applied at the different laboratories. A specific weakness is the inability to include overhead in the comparisons because overhead is calculated and charged very differently in the three surveys. Staff considerations may be compared with fewer reservations, but all comparisons of economy presented in this section must be evaluated with caution.

NGU is the smallest of the three surveys and also has the smallest laboratory. The British and Finnish surveys are both 3-4 times as big with respect to the number of staff, and their laboratory divisions are considerably larger. The GTK laboratories are the largest in terms of staff and MPYs, with an affiliated staff of 95 and a total manpower consumption of 115 (Fig. 9). This figure is exempt of the Outokumpo facility (mineral technology). The 115 MPY correspond to 15 % of the survey man power resources (Fig. 10).The BGS laboratories, with an affiliated staff of 85, exports more man power to other parts of the institution and a total of only 44 MPY are dedicated to the laboratories. The relative proportion of manpower in laboratory services (6 %) is thus the smallest among the three surveys. At NGU a total of 19.5 MPY spent at the laboratories make up 10 % of the survey staff budget.

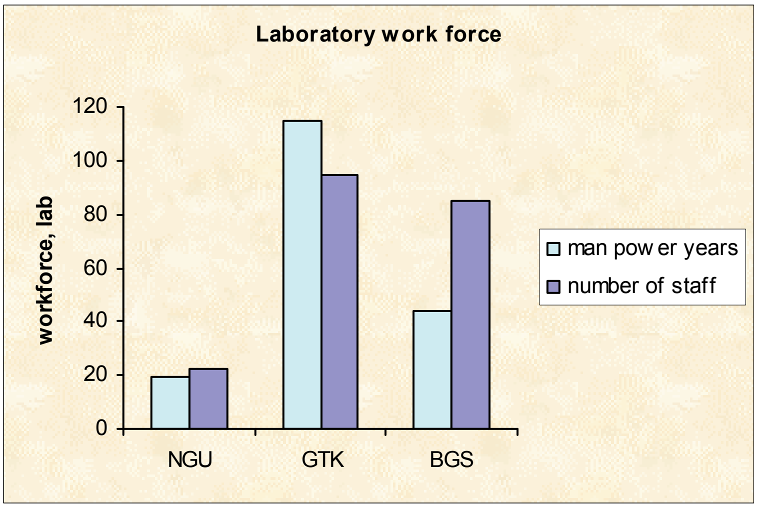


Fig. 9. Laboratory work force in number of affiliated staff and manpower years.

The running cost of each laboratory varies according to size and production. Costs including consumables, investments and staff salary costs (but no overhead) is shown in Fig. 11. The yearly cost, presented like this, of running the GTK laboratories amounts to € 6.3 mill., with BGS running at about half of this figure (€ 3.1 mill.), and NGU at slightly over a quarter (€ 1.3 mill.). These costs are thus roughly correlated with the number of MPYs spent at each lab. The data are, however, difficult to compare because overhead is not considered in the figures.

Considering only consumables, investment and salary costs the GTK-lab remain the largest laboratory also in figures relative to the overall survey economy. The selected costs for the laboratories make up 11.7 % of the total GTK survey economy. Figures for BGS and NGU are lower at 5.6 and 6.6 % respectively. Again these figures are exempt of overhead and must be compared with caution.

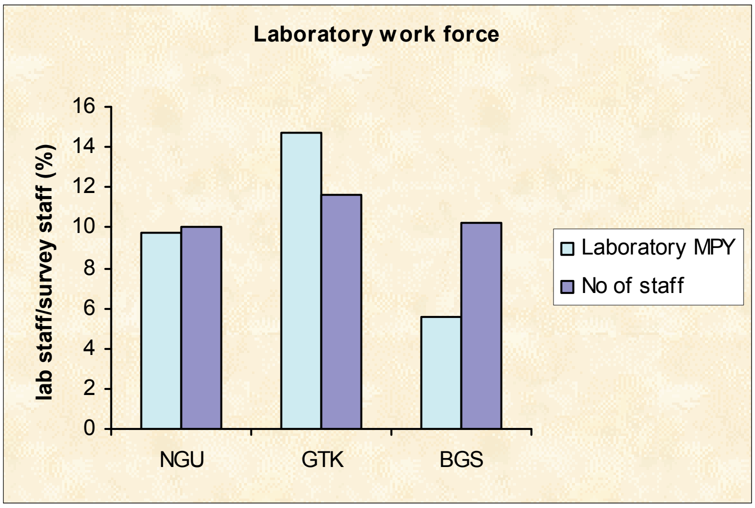
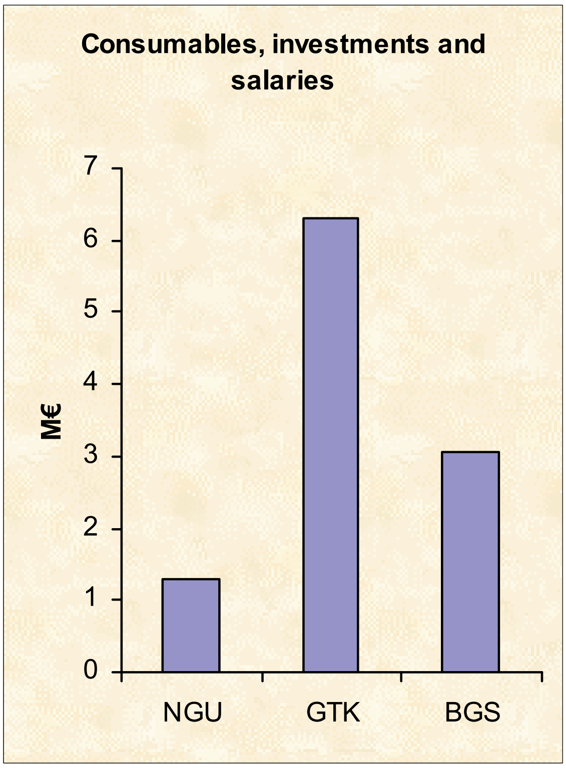


Fig. 10. Relative number of staff at the survey laboratories in terms of affiliation and MPY.



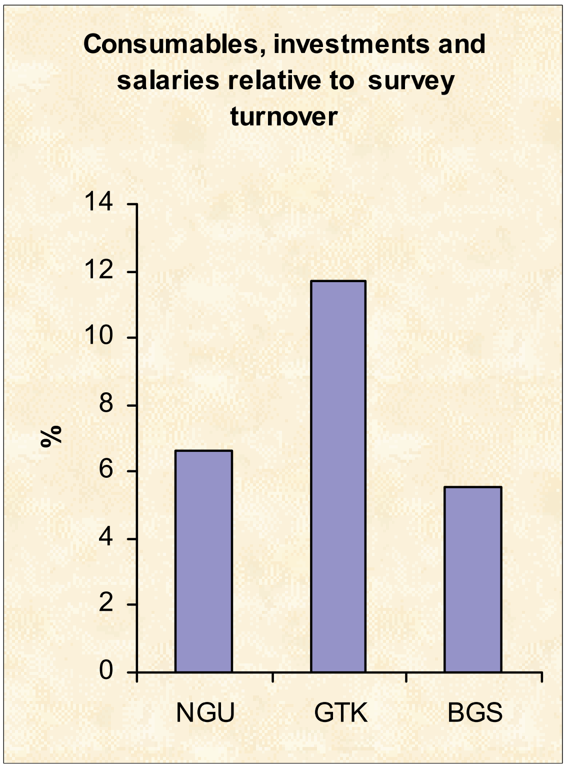
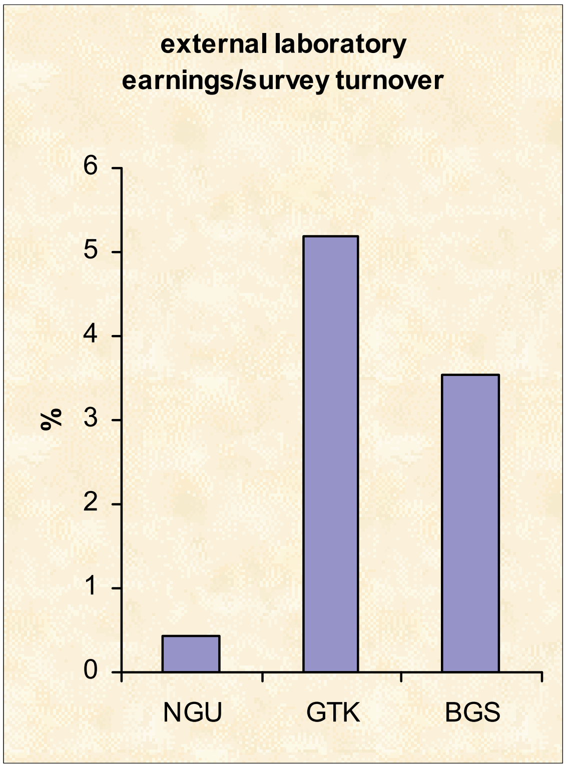


Fig. 11. Selected costs comprising consumables, investments and staff salaries for the three laboratories in absolute figures (left) and in figures relative to the total survey turnover (right). Note again the exclusion of overhead.

The commercial strategy of the three laboratories constitutes one of the most significant differences between them (see section 4). NGU-Lab is the only laboratory without a solid commercial profile and the income from external contracts is only around € 80,000. External contracts at BGS and GTK yield incomes of € 2.0 and 2.8 million respectively making up 3.6 and 5.2 % of the total survey turnovers (Fig. 12). The earnings from internally billed services are, on the other hand, rather similar for the three laboratories, considering the differences in total turnover and staff. Internally billed revenues amount to € 2.5 mill. at GTK, 1.5 mill. at NGU and 1.2 mill. at BGS. However, variation in billing practices (e.g. amount of reduced price or free of charge services), in particular for internal services, may influence the comparison.



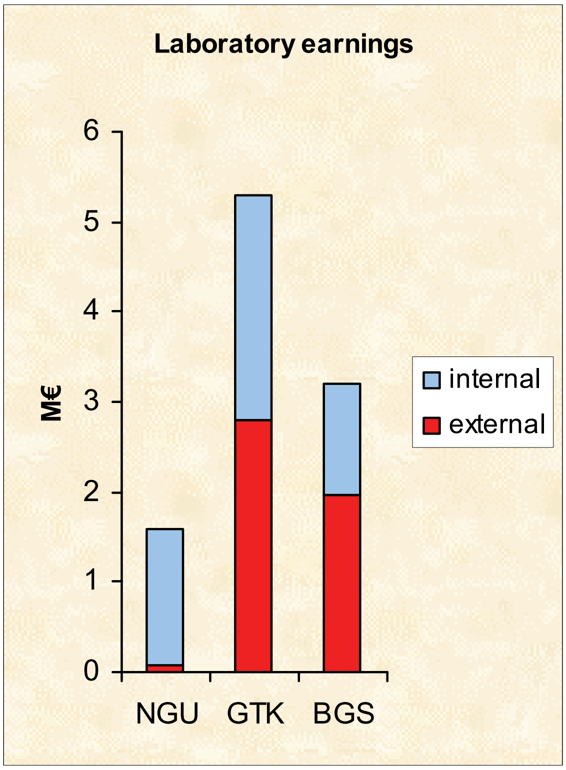


Fig. 12.External laboratory earnings relative to the overall survey costs (left) and absolute earnings in M€ for internally and externally billed contracts (right). See text for details.

5.4 Laboratory spending and personnel use

Direct expenses (i.e. excluding salaries), comprising production costs, investments, R&D activities and administration, are presented in Fig. 13. Direct spending increase with the size of the laboratories and the GTK labs have yearly spendings of € 2.3 mill. At BGS the direct expenses amount to € 1.9 mill. and at NGU the figure is 0.31 mill. Because the laboratories have different approaches to subcontracting - at NGU many subcontracts for ex-portfolio analyses are ordered directly from end user - subcontract expenses have been deducted from the dataset presented in Fig. 13. However, there are considerable differences in the level of spending, when observed relative to the number of MPY registered for each laboratory. Where NGU and GTK spend € 15,100 and € 18,100 per MPY respectively, BGS spends € 26,700 per MPY employed at the laboratories. For the size of the laboratories BGS therefore spends considerably more money than NGU and GTK.

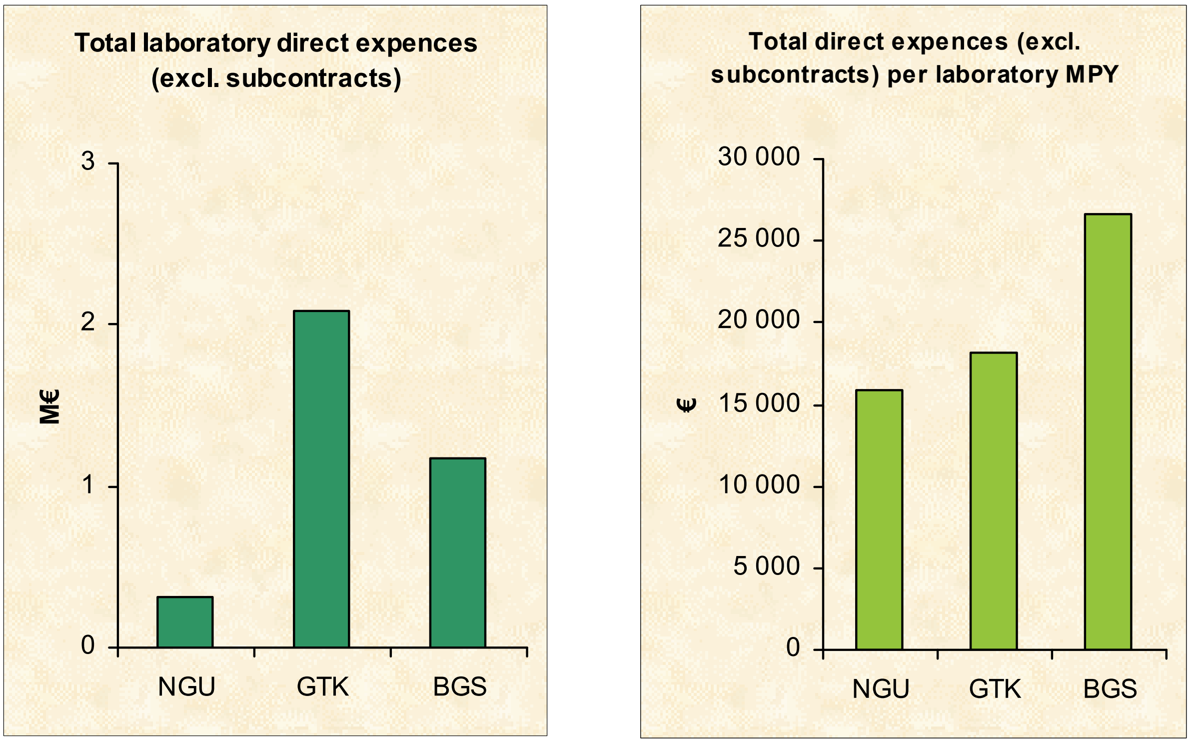


Fig. 13. Direct expenses in M€ (left) and direct expenses per MPY at NGU, GTK and BGS (right). Subcontracting is not included in direct spending in these figures.

How direct spending is used at the different laboratories is shown in Fig. 14. With regards to both direct spending and man power use in production, the three laboratories are remarkably alike. GTK does seem to be spending more money on administration than BGS and NGU, but the GTK administration figure include items such as cleaning and health care and is not directly comparable to the other laboratories. So, if one does not take into account the amount of money spent in administration, NGU, GTK and BGS all dedicate 40, 30 and 44 % respectively of their direct costs to investments, and roughly one and a half to twice this amount to production.

Quite similar with the human resources, where hardly any differences exist between the laboratories. All laboratories spend 82-83 % of their effective man hours in production, 6-10 % in R&D, and 7-11 % in administration (Fig. 14). So on this level the internal use of money and human resources is very similar.

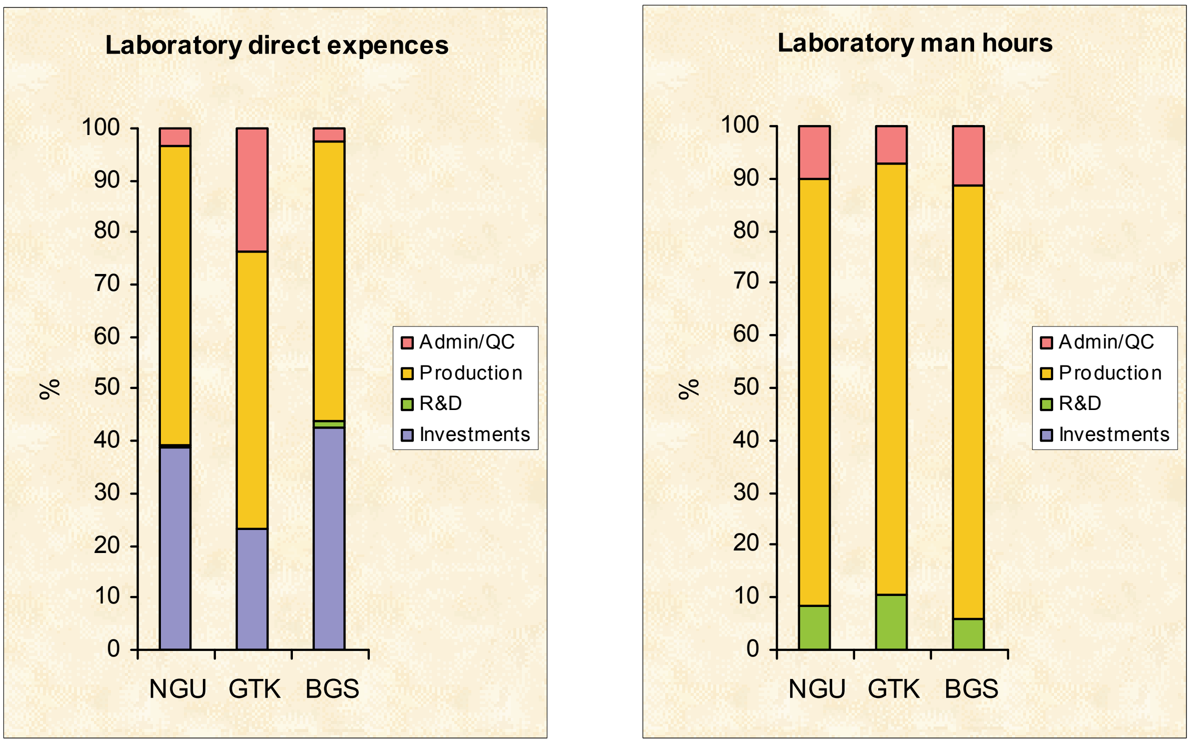


Fig. 14. Use of direct expenses and (left) man power (right) at laboratories.

Production may be conveniently itemised into consumables, service contracts and subcontracts. As can be seen in Fig. 15. significant differences exist between the laboratories as to how production costs are spent. Most of the spending at NGU-Lab goes to consumables with only 13 % of the production costs allocated to service contracts. Service contracts take up a larger part of the production costs at GTK, with 19 %, whereas BGS spends a very large proportion of the productions costs on service contracts (64 %). Money spent on service contracts will to some extent depend on the variety and choice of services offered at the different laboratories. GTK and BGS spend 7 and 2 % respectively of their production costs on subcontractors. At NGU subcontracting of for instance organic and noble element analyses, which NGU-Lab do not perform, are ordered or paid for directly from end-user, and is not included in the dataset presented here. Total analytical subcontracting at NGU exceed the total direct spending at NGU-Lab by 50 % (2005) and is thus much higher than at GTK and BGS.

A similar comparison can be performed for resource use in administration (Fig. 16) where manpower is the better parameter to present. Again the number of MPY in laboratory administration closely correlates with the size of the labs. GTK is the only laboratory with a fully implemented commercial LIMS-system, and is thus the only lab in which the cost of sample handling, analysis control, and reporting can be easily assessed. The other laboratories have their own systems for keeping track – at NGU a home made MS Excel based system handles contracts, data management and reporting. Resources spent on this type of activity is therefore included in "management" for both BGS and NGU. Personnel resources spent on quality management make up the same proportion at all laboratories.

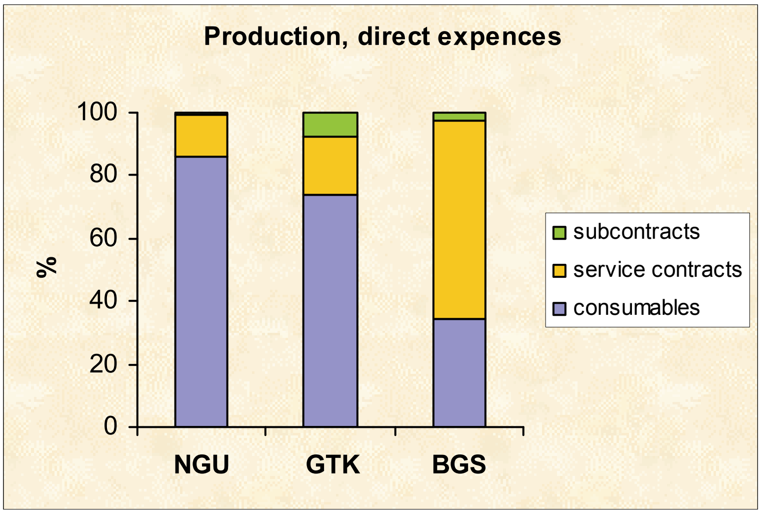


Fig. 15. Direct spending in production itemised into subcontracts, service contracts and consumables.

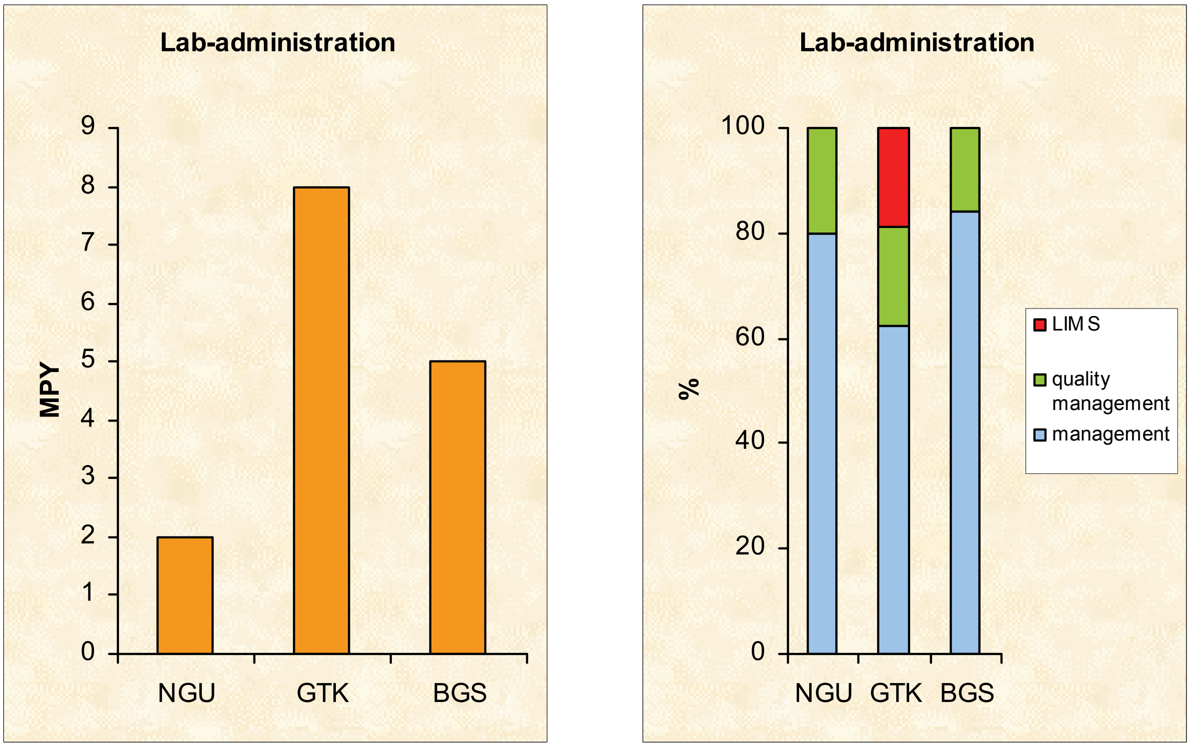


Fig. 16. Man power resources spent in administration: Number of MPYs at NGU, GTK and BGS (left) and itemised man power use in laboratory administration (right).

5.5 Quality assurance

All three laboratories are accredited according to EN-17025 for the majority of their methods, and all laboratories have implemented comprehensive quality systems.

6. ANALYTICAL SERVICES

Specific analytical activities were picked out for a closer scrutiny, both to record trends, applications and methodology, but also to assess efficiency and cost of the services provided. The quantitative data in this section strongly depend on application, scale and volume and not all data are easily compared or even comparable at all! For the sake of comparability the differences in instrumentation and methodology discussed in section 6.1 should be kept in mind.

6.1 Methods and instrumentation

6.1.1 XRF

Data include all preparation from powdered sample.

NGU routinely reports 10 major elements from fused glass beads, using $Li_2B_4O_7$ as fluxing agent (1:7). 33 trace elements are reported from powder pellets pressed with Licowax binder. Major elements are not reported from powder pellets. The instrument in use is a wavelength dispersive Philips PW 1480/10 from 1988. This instrument will be replaced by a Panalytical Axios during spring 2007.

GTK has two instruments for WD-XRF analysis; a 2004 Panalytical Axios and a 1988 Philips PW 1480/10. All analysed major, minor and trace elements are determined on pressed powder pellets. The method applied requires extensive grinding to less than 10 µm, but makes the preparation and analysis of fused glass beads needless. Glass bead analysis is thus rarely performed at all at GTK.

BGS has a wider selection of instruments including both wavelength dispersive (WD) and energy dispersive (ED) equipment (stationary and hand held). WD-XRF analysis of fused glass beads yield a selection of 10 major elements and 9 trace elements, including sulphur. Pressed powder pellets are run by WD-XRF for the analysis of 39 trace elements or by ED-XRF, where a selection of 11 trace elements can be delivered from both solids, powders and liquids. In most cases major elements of sufficient quality are reported from pressed powder pellets and routine analysis of glass beads is not required. Two grinding steps are used in preparation to ensure that grain size is sufficiently low for major element determination on powder pellets. For WD analysis BGS uses a 2005 Panalytical Axios advanced (PW4400) along with a 2001 Philips MagiX-PRO (PW2440) and a 1991 Philips PW2400. For ED-XRF analysis stationary equipment include two Panalytical Epsilon5 instruments from 2003 and 2004.

Methods thus vary, with respect to both equipment in use, and in particular to the extent of glass bead analysis for the determination of major elements. Element selections vary according to laboratory and the method applied. Otherwise the XRF-services are reasonably comparable.

6.1.2 XRD

The XRD at NGU is used extensively for clay mineral identification based on fine fraction separates (usually <2 µm or < 6µm), transferred as oriented aggregates on ceramic filters.

These are run as untreated, then treated with ethylene glycol and finally as heat treated (usually at 500 °C). The identification of unknown clastics are performed on pressed powders (back loading) or on low background (Si) discs. NGU has one XRD instrument; a Philips X'Pert MPD from 1994.

At GTK XRD is also used for qualitative as well as for semi-quantitative phase identification in powdered samples. In addition, XRD is used for the identification of clay minerals and for the identification of very small (< 1 mg) samples with the Debye-Scherrer method. GTK has three XRD instruments; a Philips X'Pert MPD from 1996, a Philips PW 1730 from 1982, and a Philips PW 1730 from 1980.

BGS performs both powder analyses, to determine and quantify whole-rock mineralogy, and analyses of <2 µm oriented mounts, to determine the nature and quantify any clay minerals present. Quantification is performed using the X'Pert High Score Plus Rietveld Quantification ICDD (2004) phase identification database. The laboratory principally carries out interpretative, applied research and is equipped with a Panalytical X'Pert Pro diffractometer and a Philips PW1700-series diffractometer.

Applications are thus quite similar, and the services should be quite comparable, taking into consideration that the relative amount of clay/clastic analysis, quantifications etc. may bias the data.

6.1.3 SEM/EPMA

The scanning electron microscope at NGU is a LEO 1450VP electron microscope acquired in 2001. The microscope is capable of running under high vacuum conditions as well as under variable pressures in reduced vacuum. It is used for both conventional electron microscopy (rocks, minerals, dust, micro fossils) as well as for electron probe microanalysis (EDS and WDS capability). The instrument is equipped with x-ray detection systems Energy 400 (EDS) and Wave 500 (WDS) from Oxford Instruments. The prime uses are mineral analyses as well as characterisation involving SE, BSE, CL and X-ray mapping. In production the instrument is primarily user-operated.

GTK has a selection of SEM/EPMA equipment including a Jeol JSM5900 LV SEM with an EDS system from Oxford Instruments purchased in 2000, a new (2005) FEI Quanta 600 SEM, and a 2003 Cameca SX100 Electron Microprobe. Applications include SE, BSE and CL imaging, quantitative elemental analysis and x-ray distribution mapping of elements using EDS or WDS. An MLA-system is used for modal mineralogy and liberation studies at the Mineral processing pilot plant.

The BGS SEM/EPMA facilities include a 1996 LEO 435VP SEM, with an Oxford instruments ISIS300 EDS system, CL, STEM and BSE detectors, and cryogenic capabilities. It also includes a Cambridge-Leica S360 SEM, with Oxford instruments EDS, WDS and CL detectors from the early 1990s. A microprobe; Cameca SX-50 (3 WDS and 1x PGT EDS spectrometer) from 1989 also forms part of the facility. The SEM equipment is principally used for high resolution petrographical and compositional analysis of rocks, minerals, soils, dusts, micro fossils and gas hydrates. The micro probe provides mineral analyses in support of survey and exploration projects.

Although applications tend to be rather similar at the three laboratories, comparability is hampered by differences in counting/billing systems. For SEM/EPMA GTK and BGS measure and bill number of samples whereas NGU only record (and bill) hours. This means that sample volumes and cost/earnings per sample, efficiency etc. are not comparable for NGU vs. BGS and GTK. The cost of services will also depend on the degree of technical assistance in user-operated applications. Contrary to GTK and BGS, NGU does not possess a regular microprobe for quantitative analysis.

6.1.4 LA-ICP-MS

At NGU LA-ICP-MS is applied to a variety of sample types, including, zircons and monazite (U-Pb direct dating), quartz, Fe-Ti oxides, talc, apatite (minerals and shells) and other minerals. Laser ablation analysis is also performed for trace element analysis (REE and other trace elements) on fused glass beads (originally prepared for XRF). The equipment at NGU consists of a high resolution Finnigan MAT element I double-focusing magnetic sector ICP-MS, and a Finnigan 266 nm UV-laser. The ICP-MS is used for laser ablation as well as for injected water and acid extracts. The ICP-MS and laser ablation system were acquired in 1997.

At BGS laser ablation is applied to solid samples of environmental, geological or industrial materials for the analysis of major, minor and trace elements. Recent applications include the composition of soil and fracture minerals with respect to nuclear contaminants, marker and contaminant elements in biogenic carbonates, provenance studies, and the analysis of various industrial products. The BGS equipment consists of a custom laser ablation microprobe (a 266nm Nd:YAG laser integrated with a Leitz microscope) coupled to a VG PlamaQuad 2+ ICP-MS instrument with S-option. The LA-ICP-MS was acquired in 1991.

LA-ICP-MS is a service offered at NGU and BGS, whereas GTK is currently considering a purchase. However, the method seems to be applied to rather different objectives at NGU and BGS, and the data are unlikely to be fully comparable on a per-sample basis (the number of analyses per sample change is a highly critical parameter).

6.1.5 Thin section preparation

At NGU the preparation of thin sections and similar services are centered around an Astera thin section "robot" from Artech installed in 2004. All actions are computer controlled and the machine is able to both grind and polish up to 32 samples at a time. The laboratory prepare standard cover-slipped and polished thin sections and stubs, double polished sections of rocks and single minerals. The facility delivers preparates for petrographic studies, apatite fission track analyses, SEM/EPMA, LA-ICP-MS and micro drilling. Additional equipment include a Logitech lapping and polishing machine PM2A and LP30, a Struers RotoPol 31 (automated polishing machine) as well as older grinding and polishing machines (GMN, Logitech, Struers).

GTK offers similar services including polished sections, and covered and polished thin sections from drill cores and rock samples. The facility make use of various, mostly older equipment (pre-1990).

BGS provides thin sections from a range of geological and anthropogenic materials (bricks, concrete, and archaeological materials). Customers comprise BGS staff, universities, oil companies and independent consultants worldwide. Services include standard cover-slipped sections and coloured resin vacuum impregnated sections, polished thin sections and blocks, fluid inclusion wafers, and polished grain sections for dating and zoning of (say), zircon grains. Equipment include five lapping machines, four grinding machines, five multi-sample and three single-sample polishing machines as well as various other utensils.

Services provided by the three laboratories seem to be quite comparable. The main differences appear to be related to the equipment in use. However, differences in the relative proportion of demanded services may affect the quantitative data.

6.1.6 Grain size distribution

Grain size analysis at NGU is performed using a Coulter LS 200 (0.4-2000µm) from 1996. Fractions larger than 2000 µm are determined by sieving and gravimetric measurements. Wet or dry sieving may be performed for fractions larger than >63 µm. The Coulter method replaced earlier testing with Sedigraph for higher efficiency.

GTK uses two Micromeritics Sedigraphs (model 5000D from 1987 and 5100 from 1992) in combination with wet or dry sieving. The sedigraph measures fractions from 0.1-63 µm.

BGS perform particle size analysis using a Micromeritics Sedigraph Model 5100 Particle Size Analyser from 1993. The sedigraph analysis is applied following sieving of coarser grain fractions.

For grain size distribution analysis BGS and GTK use identical equipment (Sedigraph) whereas NGU uses Coulter. The amount of wet/dry sieving may vary in relation to Coulter/Sedigraph analysis, but otherwise the activities seem to be easy to compare.

6.1.7 Mineral separation

Mineral separation is not well compared by the recorded data. GTK reports data for their large scale separation activities in Outokumpo, and BGS reports data only for the separation of heavy minerals from light minerals or the removal of conodonts. NGU report data for complete all-purpose mineral separation (zircons, apatites, heavy minerals etc. etc.). See appendix for details.

6.1.8 Analysis of total digests

NGU has a very low throughput of total digests, partial acid extracts by 7N HNO_3 in autoclave being the preferred media. However, for total digestion a Milestone Microwave MLS 1200 Mega from 1996, with exhaust module and a 6 position rotor for teflon bombs, is used. The service is only used for "special" applications where partial extracts are not sufficient. Samples are often related to product control of mineral products. After digestion, samples are analysed by either ICP-AES, AAS or HR-ICP-MS, or any combination of these methods according to purpose and sample type. For instrumentation, see following section (6.1.9).

BGS's throughput of total digests and acid extracts is dominated by total digests, accounting for about 95 % of the samples. The method applied is a sample dissolution using HF mixed acid attacks. After digestion the samples are analysed by either ICP-AES or ICP-MS. The ICP-AES instruments in use is a Fisons/ARL 3580 simultaneous/sequential spectrometer from 1989 and a Varian Vista Axial Pro from 1998. The ICP-MS instrument is a VG ExCell with collision cell, purchased in 2000. The ICP-MS is mainly used to supplement XRF analyses with REE, HFSE, U and Th, whereas ICP-AES is used for the determination of a range of major and trace elements. For the analysis of Hg, BGS uses atomic fluorescence spectrometry.

GTK provide analyses of total acid digests for the determination of major, minor and trace elements, including REE, as well as additional components, such as Fe^{2+}, S, C, $H_2O^{+/-}$ etc.

Major, minor and trace elements are analysed with multi-element techniques (ICP-AES or ICP-MS) and the "additional components" with element-dedicated methods. Analytical instrumentation include a Perkin Elmer Sciex Elan 5000 ICP-MS purchased in 1990 and two ICP-AES'es; a Thermo Jarrel Ash IRIS AP / HR DUO acquired in 1998 and a Thermo Jarrel Ash Polyscan 61 E from 1989.

For the analysis of total acid digests, the throughput at NGU is too low to be reliable, but otherwise applications and instrumentation are to some extent comparable. NGU is the only lab to use a high-resolution ICP-MS, and GTK and BGS both have a much wider selection of instrumentation available for multielement analysis.

6.1.9 Analysis of acid extracts

NGU perform acid extraction analysis by extraction autoclave in 7N HNO_3, followed by a variety of instrumental procedures. Most samples are analysed by ICP-AES, often combined with AAS analyses of Hg (by CV-AAS) or one or more other environmentally critical elements (e.g. Pb, Cd, As, Se, Sn) by GF-AAS. More rarely, samples are analysed by HR-ICP-MS in combination with ICP-AES. NGU uses a Perkin Elmer Optima 4300 DV ICP-AES from 2003, a high resolution Finnigan MAT element I double-focusing magnetic sector ICP-MS from 1997, a Perkin Elmer, SIMAA – 6000 AAS from 1995, and an M-6000A Mercury Analyzer (CV-AAS) from Cetac, purchased in 1999.

Partial leaches at GTK include a range of methods. For geochemical research and base metal exploration Aqua Regia is used, whereas HNO_3 leaching, using microwave oven technique, is preferred for environmental samples. Selective leaches using enzymes, water, ammonium acetate, $BaCl_2$, KCl, $CaCl_2$, pyrophosphate etc. are also used for exploration purposes, and for the assessment of contamination load on soils and sediments, speciation studies, and chemical properties of soil. All leaches (as well as fire assays) are followed by ICP-AES or/and ICP-MS finish. Analytical equipment comprise 6 ICP-AES'es and 1 ICP-MS (a Perkin Elmer Sciex Elan 5000 from 1990). The 6 AES-instruments are; a 1989 Thermo Jarrel Ash Polyscan 61 E, a 1992 Thermo Jarrel Ash Polyscan 61 E, a 1994 Thermo Jarrel Ash IRIS Axial Plasma upgraded to High Resolution Dual View, a 1998 Thermo Jarrel Ash IRIS AP / HR DUO, a 1999 Thermo Jarrel Ash IRIS Advantage, and a 2001 Thermo Jarrel Ash IRIS Advantage.

Of all digests and extracts analysed at BGS, partial extracts only make up about 5 %, equivalent to less than 200 samples per year. BGS therefore did not submit data for this type of analyses. Analytical equipment is in principle the same as described in the previous section (6.1.8).

The analysis of acid extracts covers a range of methods both in preparation and analysis. Typically these will vary according to purpose and influence comparability. The major difference, however, is in the scale of operation!

6.1.10 Analysis of water

At NGU natural water make up 90 % of all water samples analysed. Only inorganic analyses are performed, but the variety and extent of methods applied vary according to samples and purpose. Analytical methods include cations determined by ICP-AES, CV-AAS, GF-AAS or HR-ICP-MS (see section 3.1.9), as well as anions determined by ion chromatography (IC), and physical parameters comprising pH, conductivity, colour index, turbidity and alkalinity. For IC, a Dionex DX 120 Ionic Chromatograph, purchased in 1999 is used for the analysis of F^-, Cl^-, NO^{2-}, Br^-, NO^{3-}, PO_4^{3-} and SO_4^{2-}. A Radiometer Titralab 94 (from 1996) is used for the analysis of Ph, alkalinity and electrical conductivity, a Shimadzu UV 1201 spectrophotometer (from 1993) is used for colour number, and a Hach 3100A Turbidimeter (1993) is used for the measurement of turbidity.

GTK analyses household water, natural surface and ground waters, as well as rain waters. Protocols may include a nitric acid decomposition for "total analysis". Anions are measured with ion chromatography, and physical parameters determined include pH and electrical conductivity. The analytical equipment comprise; a 1988 Varian VGA 76 / GTA -96 Hydrid Generator, a 1989 Dionex System 2000 ion chromatograph, a 1995 Perkin Elmer Sciex Elan 6000 ICP-MS, a 1998 Thermo Jarrel Ash IRIS AP / HR DUO ICP- AES, and a 1999 Mettler automatic titrator.

At BGS services related to water analyses include pH and alkalinity, multielement analyses by ICP-AES or ICP-MS, ion chromatography (F^-, Cl^-, NO_2^-, Br^-, NO_3^-, HPO_4^{2-}, SO_4^{2-}, and S_2O_3, bromate and chlorate), TOC, reduced Fe, iodine, N species and Hg. BGS has access to a large assortment of instruments, of which some are considered shared use instruments owned wholly or partly by CEH. The instrument park include: Two TIM 860 (2002) and 865 (2004) TitraLab Radiometers. 3 ICP-AES instruments; a Varian Vista Axial Pro from 1998, a Perkin-Elmer Optima 3300 DV, purchased 1998 and a Fisons/ARL 3580 simultaneous/sequential ICP-AES from 1989. A VG ExCell ICP-MS, with collision cell acquired in 2000, a (UV absorbance) Dionex DX-600 Ion Chromatograph from 2001 and a Dionex DX-500, ECD detector, acquired in 2000. A Shimadzu TOC 5000 analyser from 1990, a Shimadzu TOC-V CPH analyse from 2004, as well as an analytical Sciences Thermalox. A Bran & Luebbe AA3 dual-channel continuous segmented flow analyzer, purchased in 2000, for iodine analysis and a Skalar SAN 4-channel continuous segmented flow analyzer, purchased in 2001, for nitrogen species analysis. For Hg-analyses, BGS use a PS Analytical Ltd. Millennium Merlin Atomic Fluorescence Spectrometer purchased in 2004.

As for the analysis of extracts and digests, the selection and range of methods applied in the analyses of water is highly variable. The data, however, still seem to be comparable keeping these differences in mind.

6.1.11 TC, TOC, TS

Total carbon (TC), total organic carbon (TOC) and total sulphur (TS) was not originally included in the exercise, but data have been submitted by both NGU and BGS.

NGU uses a Leco furnace to analyse TC, TOC (after acidification) and TS. The instrument used is a LECO SC-444 from 1992. Typical samples comprise (marine/non-marine) soils and sediments, carbonates etc. etc. NGU-Lab do not perform these analyses on aqueous samples.

BGS also determines TC and TOC in solid geological materials (e.g. soil, rock, sediment, coal, etc.), but not total sulphur. The instrument used is an Elementar, CN VarioMax Total Carbon Analyser, acquired in 2003. BGS also analyse carbon (TC, TOC) in aqueous solutions (data not included in report).

For further details on equipment, methods and applications the reader is referred to the appendix.

6.2 Sample throughput

Fig. 17 shows the sample throughput for a selection of analytical activities for the three laboratories. The most distinctive anomaly is the very high yearly volume of acid extracts analysed at GTK, which is almost 30 times larger than what is analysed at NGU (BGS did not submit data for partial extractions because it is a technique that is only very rarely applied at BGS). Significant is also that the analysis of total acid digests is an important activity at both BGS and GTK, but only rarely performed at NGU.

XRF is an important method in all laboratories but with throughput roughly 250 % higher at GTK and BGS than at NGU. Similarly for XRD, where throughput is up to six times higher at GTK and BGS compared with NGU – the request for this type of analysis is, however, strongly increasing at NGU as well. Though the numbers are not directly comparable, electron probe analyses and laser ablation (NGU and BGS) techniques are also seen to attract considerable sample volumes. For thin section preparation and grain size distribution analysis the institutions are quite comparable whereas for water and digests NGU have much lower throughput than both BGS and GTK. Mineral separation is man power intensive and the number of samples processed per year is low.

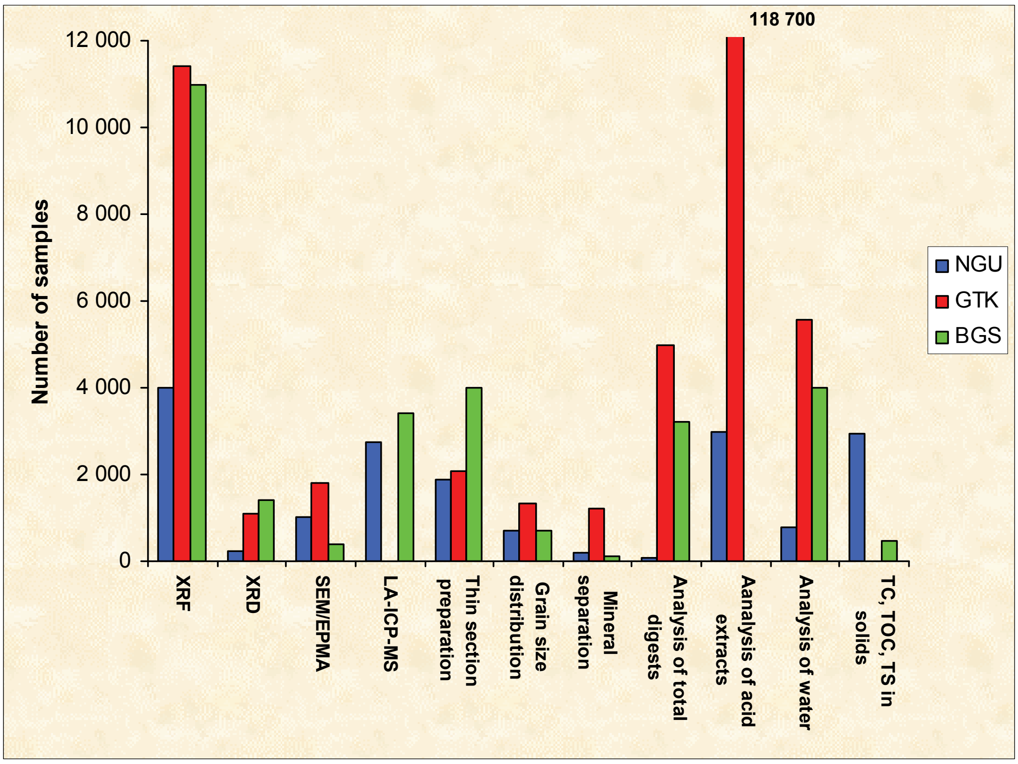


Fig. 17. Sample throughput for selected activities at the different laboratories. Note that the GTK figure for analysis of acid extracts is off scale (118,700 samples).

6.3 Efficiency

A measure for the efficiency of applied methodology, personnel and equipment can be seen in Fig. 18., where the number of processed samples per MPY are plotted. Such numbers will also strongly depend on the sample volumes and applications.

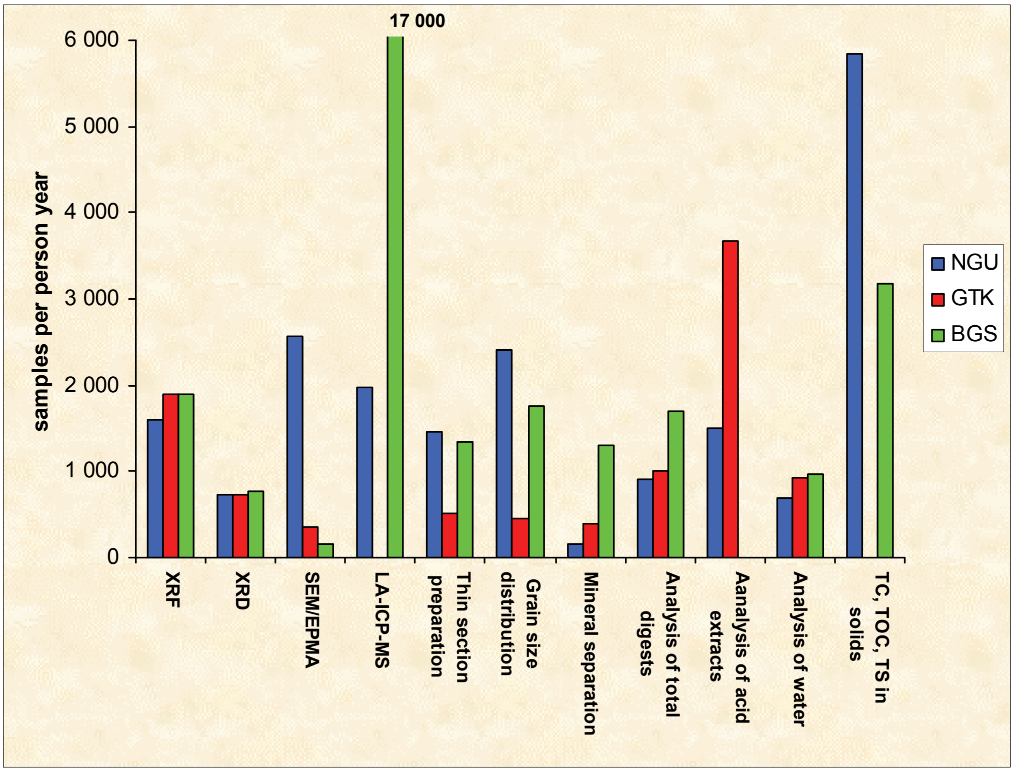


Fig. 18. "Efficiency" measured as samples per MPY at activity. Note that the BGS figure for LA-ICP-MS is off scale (17,000 samples)

For LA-ICP-MS and mineral separation the data are incomparable due to the difference in application, and NGU does not compare well with BGS and GTK for SEM/EPMA. Otherwise the dataset seems quite illustrative and the differences in "effectivity" are in no way extreme. The efficiency in XRF analyses is quite similar for the three laboratories, bearing in mind that different "packages" are reported at each place. However, as NGU in most cases analyse both pressed powdered pellets as well as fused glass discs on the same sample, real efficiency per submitted sample is likely to be low. For XRD the data are almost identical whereas for SEM/EPMA, GTK seems to have somewhat higher "efficiency" than BGS, which may or may not be related to application or data recording (at BGS, at least, the figure include amount of time spent with interpretation). For grain size distribution analysis and thin section preparation larger differences exist, with NGU processing the highest number of samples per MPY and GTK the lowest. In thin section preparation the data are highly dependant on the amount of special preparates, polishing etc. demanded, and for grain size distribution the data also depend on the proportion of sieving and coulter/sedigraph testing etc. The data for grain size distribution may to some extent reflect the reduced need for sieving using Coulter technology (NGU) vs. Sedigraph testing (GTK and BGS). For the analysis of total digests BGS reports the highest number of samples per MPY – the sample throughput at NGU is too low to be reliable for accuracy. GTK has a very large throughput of acid extracts compared with NGU resulting in a very high efficiency for this type of analysis, with 2.5 times as many samples processed per MPY. Analysis of water yield similar values for the three labs whereas NGU seems to produce more data per MPY than BGS from TC/TOC/TS.

6.4 Costs

The cost per sample is a function of man power use and cost as well as direct expenses (Fig. 19). It is a more convenient parameter to compare than for instance price, because the latter may vary with sample volumes etc. associated with specific contracts or other considerations. The total cost per sample diagram take into account all direct costs associated with the specific activities as well as the man power salaries, including social costs but excluding other overhead costs as in previous figures and discussions. The cost per sample parameter is likely to correlate with the efficiency recorded for particular activities (Fig. 18) at each institution.

Apart from SEM/EPMA, LA-ICP-MS and mineral separation, where the data do not compare well, the picture is rather similar to the "efficiency" plot (Fig. 18). The cost per sample is rather similar for XRF, XRD, analysis of total digests and the analysis of water, with NGU generally having slightly higher costs than BGS and GTK and BGS mostly having the lowest costs. For thin section preparation, grain size distribution and TC, TOC and TS in solids the differences are bigger and NGU generally having the lowest costs per sample. In the analysis of acid extracts GTK have far lower costs per sample than NGU, again most likely attributable to the very differing sample throughput.

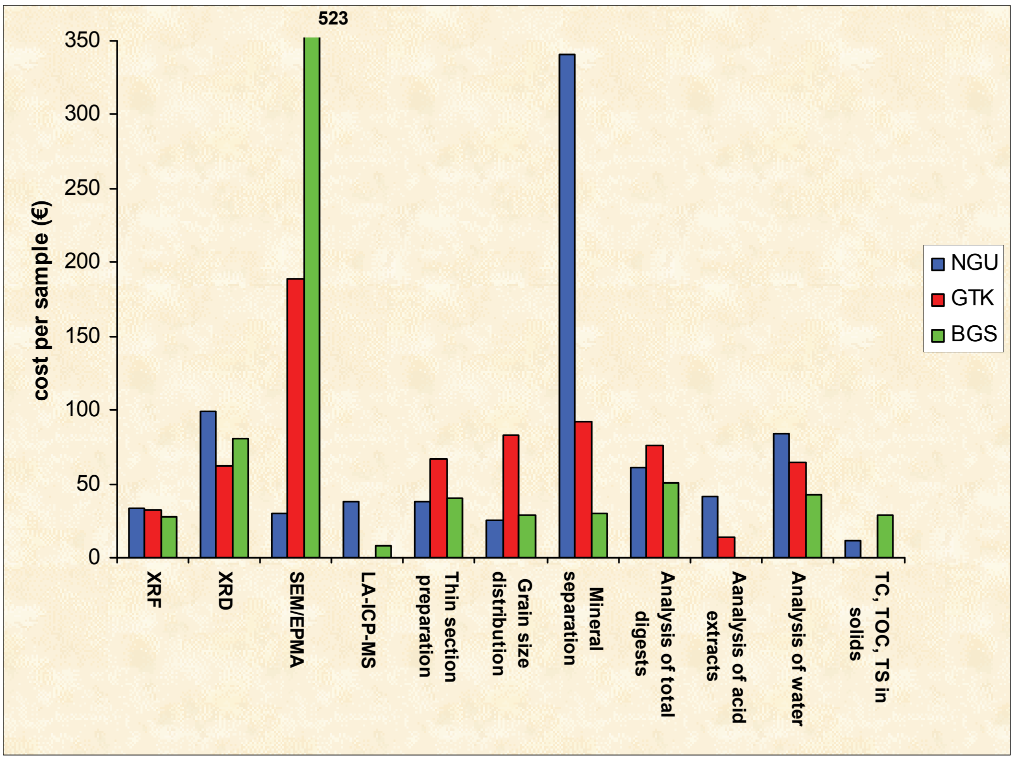


Fig. 19. Total cost per sample based on sample volumes, direct costs and cost of man power, excluding only salary overhead. Note that the BGS figure for SEM/EPMA is off scale (€ 523).

6.5 Income

Fig. 20. shows where the different laboratories earn their money. The total income for activities will depend on the price strategy and contract/sample volume for the specific activities.

The singularly most outstanding feature of the diagram is the importance of acid extract analyses at GTK with a yearly revenue of € 2.28 mill. The analysis of acid extracts is also the most important source of income at NGU-Lab but the earnings remain an order of magnitude lower. For BGS, XRF is the most important source of income among the activities investigated and it is the second most important activity at both GTK and NGU. The BGS earnings are, however, lower with respect to their sample volume compared with NGU and GTK (compare with fig. 17). At GTK the analysis of acid digests and water analyses are important activities, generating incomes in excess of € 300,000. Water analysis is the second most important earning activity of the investigated services at BGS with yearly revenues of € 348,000, followed by SEM/EPMA and the analysis of acid digests earning € 218,000 and 142,000 respectively. LA-ICP-MS is much more important at NGU (third largest in earnings) than at BGS and the activity does not exist at all at GTK. On the other hand SEM/EPMA analysis tend to be relatively less important at NGU than at BGS and GTK. The picture for each activity roughly corresponds to the sample volume, but generally BGS have much lower earnings compared with their sample throughput than both GTK and NGU.

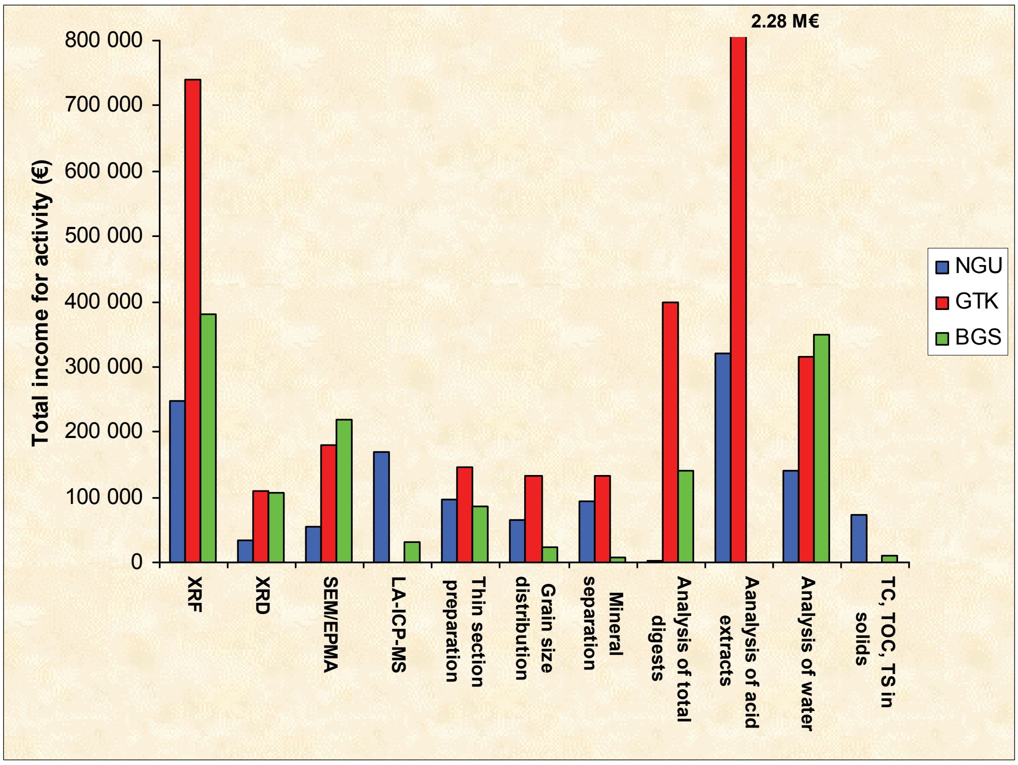


Fig. 20. Total income reported for the selected activities. Note that the GTK figure for the analysis of acid extracts is off scale (€ 2.28 mill.).

If the total income is plotted in percent of the total costs for each activity, a measure of the profit margin is obtained. As before overhead on personnel hours are not included in fig. 21. The profit margin is a potential instrument for regulating price of services and it can be seen that NGU generally price its services for a higher margin than both GTK and BGS. All data points but one is above 130 %. This could be a result of either higher overhead costs at NGU or a more stringent demand for balancing the internal budgets. The most important earning activities at NGU, acid extract analysis and XRF, yield profit margins of 255 and 184 %, respectively. Of the ten data points reported by BGS only four activities yield margins over 110 %. However, the two most important activities at BGS, XRF and water analyses, have profit margins of 124 and 204 %, respectively. At GTK six out of nine investigated activities have profit margins above 110 %, the most important ones, the analysis of acid extracts and XRF, have margins of 140 and 199 %, respectively.

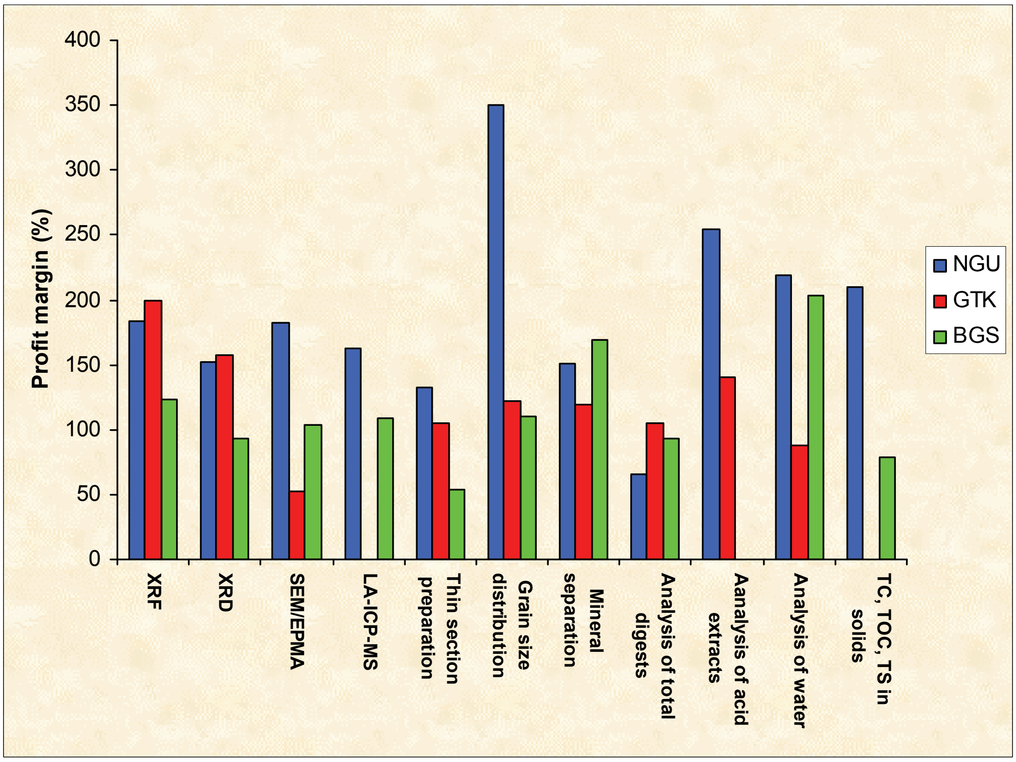


Fig. 21. Profit margin for the investigated activities not taking into account the overhead. Profit margin is calculated as % income divided by the total costs for each activity.

6.6 Instrument capacity

Instrument capacity may be used to illustrate where each laboratory have a potential for increasing production by relocating man power. It also shows where the laboratories may be most vulnerable to instrumental failures. Fig. 22. demonstrates the estimated use of the potential instrumental capacity in percent for the various activities at the three laboratories.

For NGU it can be seen that the most exploited services include LA-ICP-MS, extractions, thin sectioning, SEM/EPMA and XRF whereas activities such as XRD and water analyses are running well below capacity. At GTK most services seem to be running at close to 2/3 of maximum capacity and only total digestion analysis has a throughput of less than 50 % of the maximum processing volume. The picture for BGS is more variable with thin section preparation and XRF operating at more than 2/3 of maximum capacity, but with almost all the rest of the investigated services having ample unexploited capacity. This probably largely reflects the dedication of many of BGS's laboratories to scientific research.

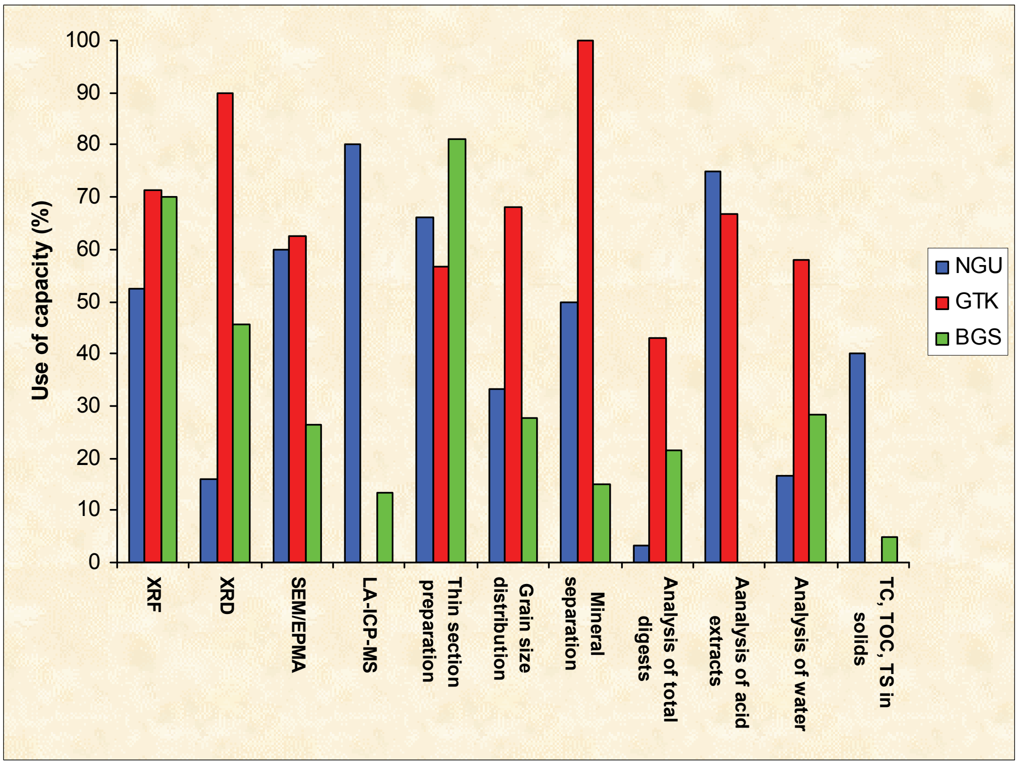


Fig. 22. Spent versus potential instrument capacity for the selected activities.

6.7 Future expectations

The three laboratories were also asked to indicate their expectations to the future sample volume for the investigated activities. The result, translated into a scale from –1 to 1 is shown in Fig. 23. The result is likely to be highly subjective, but potentially gives an indication of where geosurvey laboratories are moving. The net result, however, is that on average almost all the investigated activities are expected to increase in the coming years. This could be taken as a sign that geosurvey laboratories are not expecting any major changes in the demand for geological preparates or standard mineralogical and geochemical analyses - apart from more samples in general. Novel or upcoming techniques are, however, not included in the exercise.

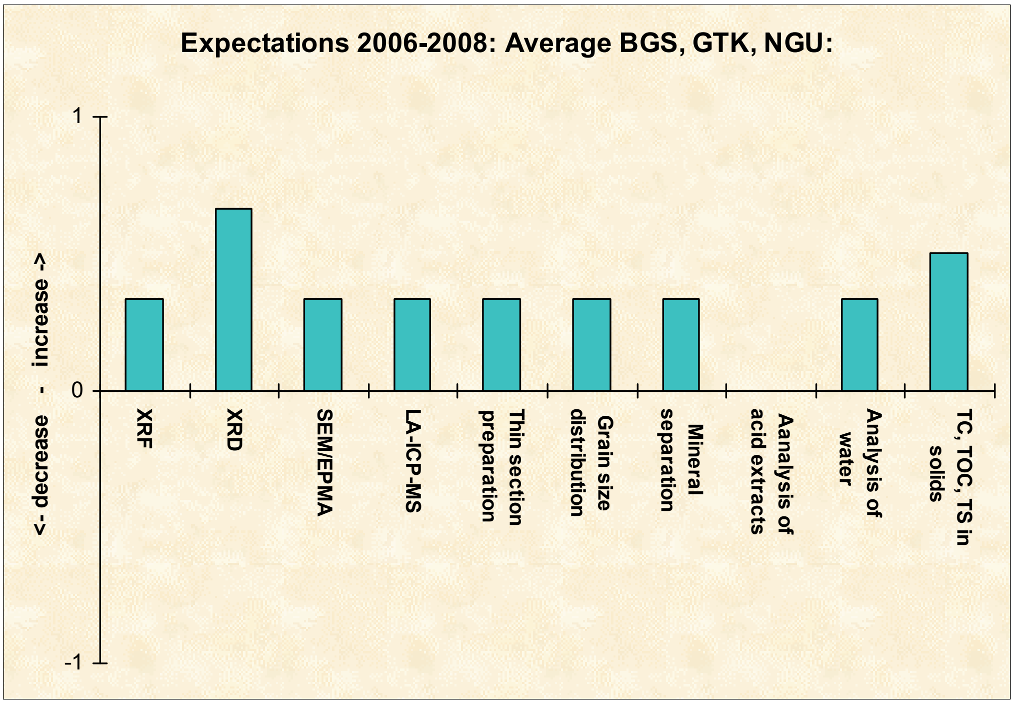


Fig. 23. Expectations to the individual activities in a three-year perspective. Average of responds from NGU, BGS and GTK. Answers translated to "1" expected increase, "-1" expected decrease, and "0" status quo.

7. CONCLUSIONS

This benchmark study of the laboratories at NGU (Norway), GTK (Finland) and BGS (Great Britain) has sought to outline basic characteristics concerning the laboratories with regard to size and structure, resources and economy, portfolios, instrumentation and methodology etc. The ultimate purpose of the exercise is to provide a tool (benchmark) to improve performances, and help each laboratory and its parent survey prepare for up-coming strategic challenges.

The three laboratories have many similarities in spite of the marked difference in size. A wide range of classic geosurvey laboratory services are common to all labs even though sample throughput for the various activities may differ on orders of magnitude. Probably the most prominent difference between the laboratories is their commercial profiles and the resulting disparity in amount of "external" contracts. Otherwise, in terms of relative spending in administration and production, R&D, level of investments, earnings, applications and equipment, as well as future expectations, the laboratories are with few exceptions remarkably similar. All three laboratories are accredited according to EN-17025 for the majority of methods, and all laboratories have implemented comprehensive quality systems.

Scoreboards and detailed performance critics are intentionally omitted from this report. Conclusions based on the current content should, by accord, be drawn internally.

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APPENDIX

Geolaboratory benchmarking, 2005/2006

Appendix

Laboratory at Institution: Geological Survey of Norway (NGU)

Laboratory staff	Number	Average salary	Survey staff	
Staff profile: PhD	4	50 000	No of PhD	64
MSc/BSc or equivalent[a]	6	41 500		
Non-university	12	35 000	Total staff at survey	220[b]
Total staff at lab.	22		FTE	200

Laboratory expenditures (years and €/yr)	Person years[c]	Staff costs[d]	Direct expences[e]
Laboratory total exp. excl. Ar-Ar Lab	19.5	975 000	310 000
Investments	0.0	1 000	120 000
R&D	1.6	91 000	1000
Production	15.9	768 000	179 000
Consumables			145 000
External maintenance and service contracts			24 000[f]
Subcontracts			1 000[g]
Administration	2.0	115 000	10 000
Management	1.6	92 000	2 000
Quality management	0.4	23 000	8 000
LIMS	0	0	0

Total turnover at institution (M€/yr) 19.4

Laboratory earnings (€/yr) External: 82 000 Internal: 1 500 000

Cost of premises (€)*** 330 000[h]

Quality system

Frequency of external audits (specify)	1 per year
Frequency of internal audits (specify)	1 per year – all accredited activities are audited by laboratory employees over a two-months period.
Customer satisfaction: method of assessment, last date or frequency of questionnaires etc. etc.	No routine assessment. Last questionnaire for internal customers returned in 2001. Selected external customers (also lab) asked for oppinion on NGU, as a whole, in 2003

*) The figure comes in addition to the (total) regular laboratory administration costs further up. It can probably only be estimated.

**) Salaries refer to money actually paid out. Overhead here should include both social costs (pensions and other benefits) as well as premises, in-house services etc. etc.

***) premises should be calculated as the average rent, heat, electricity, water etc. per area multiplied by the total laboratory area. The figure makes up part of the salary overhead.

General Portfolio

1	XRF, 10 major and 30 trace elements	21	Thin section (a.o.) preparation
2	ICP-OES: 30+ elements	22	X-ray core inspection
3	GF-AAS: As, Cd, Pb, Sb, Se, Sn	23	(VSM)[i]
4	CV-AAS: Hg	24	(Ar-Ar)[i]
5	Leco: TS, TC, TOC		
6	XRD		
7	IC: F, Cl, Br, NO_3, PO_4, SO_4		
8	pH, conductivity, alkalinity		
9	colour index, turbidity		
10	SEM/EPMA		
11	ICP-MS: water (41 elem), leaches (9 elem)		
12	LA-ICP-MS: minerals and fused disks (21 el)		
13	Grain size distribution: Coulter LS/sieving		
14	LOI: 480 and 1000ºC		
15	Extractions (total, partial, weak)		
16	Palynology/dinoflagellate preparation		
17	Mineral separation		
18	Mech. testing: PSV, ball mill, Los Angeles		
19	Remanens, susceptibility, density		
20	Thermal conductivity		

Additional comments:

[a]) The figure includes two persons who have BSc-equivalent competence.

[b]) Of the total number of staff 70 are women. Of the total number of staff 116 are researchers, 32 researchers are female. Number of MPY totals around 200.

[c]) One man power year (MPY) is calculated as 1850 hours. For each sub-item (production, administration etc.) efficient MPY are used (1500 hours). This means that holiday, absence etc. are included in all figures.

[d]) Based on current exchange rate of 8 kr/€. All hours and costs for holiday and absence are included in items. Total costs include social costs - the total cost is calculated from salary as 1.243*salary or 1.262*salary for staff younger/older than 60 resp. One MPY at NGU-Lab averages € 50 000 (salaries + social costs, no overhead).

[e]) 2005 was atypical with low level of investment – figures are average of previous five years.

[f]) Service contracts include XRF, XRD, colour index, coulter, Leco, SEM, ICP-OES

[g]) Figure represents subcontracts ordered by NGU-Lab. Totally NGU subcontracts (2005) for about € 300 000 to external laboratory services – these are mostly ordered by end-users or even external clients.

[h]) Cost of premises calculated as 1980 m^2 x 167 €/m^2 (rent alone is 120 €/m^2)

[i]) Activity not in control of laboratory department.

Test scheme for activity: ***XRF***

Instrumentation, including age, model and make:

WD, Philips PW 1480/10, with Rh X-ray tube. Generator 3 kW (max 100kV, 75 mA) from 1988. 72 pos. sample changer. X40 sottware ver. 4.0 H (1999).

Brief description of method and applications (include comment on level of R&D vs. production):

Mainly used for rock samples

Sample prep.
i) Major elements
Glass beads, Flux $Li_2B_4O_7$, Ratio 1:7. Melting equipment. Claisse Fluxer-Bis (1988/1996, 6 pos.) and PerlX2 (1987, 1 pos).
ii) Trace elements
Pressed pellets, Hoecst Wax as binder, 5.4 g sample and 1.2 wax

Method related information
i) Major elements
Theoretical alpha's. Measuring time (s) : 624. LOI included in analysis except for limestone and dolomites (no pre-ignnition)
ii) Trace elements
Elements : As, Ba, Ce, Cl, Co, Cr, Cs, Cu, F, Ga, Hf*, La, Mo, Nb, Nd, Ni, Pb, Pr, Rb, S, Sb, Sc, Sn, Sr, Ta, Th, U, V, W, Y, Yb, Zn, Zr.. All elements not included in one program, to obtain all elements each samples has to be run on two programs (where both also include measurement of major elements wrt. matrix corrections). Trace A : Mo, Nb, Zr, Y, Sr, Rb, U, Th, Pb, Cr, V, As, Sc, Hf, S, Cl, F. Trace B : Ba, Sb, Sn, Ga, Zn, Cu, Ni, Yb, Co, Ce, La, Nd, W, Cs, Ta, Pr
Measuring time : 1090 (Trace A) + 1340 (Trace B) = 2430 s
For most elements Rh Compton as ratio channel.

Software : Philips X40 version 4.0H (1999)
R&D :< 5 %

Near future investments (planned/expected/required):

Application for new XRF submitted late 2004. Expected approval in 2006. Estimated cost is around € 250 000.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: YES

Comment if yes: Hf, Cs, Ta and Pr not included in accreditation

Participation in proficiency testing – number of tests per year for activity: 2

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year[a]:	300	3 700	4 000
Income received per year (€)[b]:	18 000	230 000	248 000

Sample volume in % of total volume at laboratory[c]: 7

Instrument utilisation (hours per year): 2 100

Theoretical max. utilisation: 4 000

Man years on activity[d]: 2.5

Staff costs on activity (€): 127 000

Expenses on service contracts in €/yr: 4 200

Direct costs of activity €/yr (excluding service contracts): 3 800

Additional comments:

[a]) Number of samples refers to number of analyses – if both major and trace elements are requested the sample is counted twice.

[b]) Income does not include income from preanalysis (crushing, splitting and milling)

[c]) Sample volume is counted as number of "analytical actions" requested – one sample typically requires more than one type of analysis or pre-treatment. Total "sample volume" of 60 000 is therefore higher than the actual number of samples submitted to lab.

[d]) Counting effective hours (1500 hours per year) – figure thus takes into account leave of absence, holiday etc. etc. Average of 2004-2005 is 3800 effective hours.

Test scheme for activity: ***XRD***

Instrumentation, including age, model and make:

Philips X'Pert MPD, Cu X-ray tube, 21 pos. sample changer, programmable optics, θ-θ goniometer, Miniprop. detector (1994). Software: X'Pert line ver.1.2 d (2000). ICDD database from 1994. Additional software: Philips ProFit ver. 1.0c (1996)

Brief description of method and applications (include comment on level of R&D vs. production):

Mainly used for qualitative analysis (identification) in geological materials, but also sometimes for quantitative analysis.

Clay minerals

Clay minerals identification based on fine fraction (usually <2 µm or < 6µm), transferred as oriented aggregates on ceramic filters. Run as untreated followed by ET-treated and heat treated (usually at 500 °C)

Other

Mainly prepared as pressed powder (back loading), but in some cases small samples prepares on "low background disc" (Si-disc)

Quantitative analysis

At present only performed on special request, normally based on relating "whole" patterns to pattern of pure minerals. Calculations usually based on either the methodology given in FULLPAT ("A Full Pattern Quantitative Analysis Program for X-ray Powder Diffraction", Steve J. Chipera and David L. Bish, calculation in MS Excel with use of the solver add inn), or Partial Least Square Regression (Unscrambler software).

R&D

Approx. 50 %

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	20	200	220
Income received per year (€):	3 000	30 000	33 000

Sample volume in % of total volume at laboratory: < 1

Instrument utilisation (hours per year): 400 *Theoretical max. utilisation:* 2500

Man years on activity: 0.3[b] *Staff costs on activity (€):* 14 000

Expenses on service contracts in €/yr: 3 750

Direct costs of activity €/yr (excluding service contracts)[a]: 4 000

Additional comments:

[a]) The estimated annual direct costs are somewhat elevated due to major/expensive faults in 2004 (new X-ray tube) and 2005 (replacement of HT-tank and MPPC).

[b]) 430 hours in 2005 (effective)

Testscheme for activity: SEM/EPMA

Instrumentation, including age, model and make:

1450VP electron microscope from LEO Electron Microscopy Ltd. (now Carl Zeiss) - capable of running under high vacuum conditions as well as at variable pressures in reduced vacuum. The instrument was purchased in 2001.

Electron detection system consists of a secondary electron (SE) detector, two back-scattered electron (BSE) detectors and one detector for cathodoluminescence (CL). The instrument is currently also equipped with an absorped current detector.

X-ray detection systems Energy 400 and Wave 500 from Oxford Instruments include an 133 eV resolution energy dispersive spectrometer (EDS) and a wavelength dispersive spectrometer (WDS).

Brief description of method and applications (include comment on level of R&D vs. production):

The scanning electron microscope at NGU is a versatile instrument which is used for both conventional electron microscopy as well as electron probe microanalysis. The prime uses are:

Mineral analyses in polished thin sections.
Mineral characterisation involving BSE, CL and X-ray mapping.
Investigation of micro fossils relating to climate issues.
Various chemical and physical characterisation of mineral products, dust etc. etc.

In production the instrument is primarily user-operated and the laboratory involvement is mainly dedicated to maintenance, training and development.

Near future investments (planned/expected/required): None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 1[a]

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year[b]:	25	1 000	1 025
Income received per year (€):	2 000	53 000	55 000

Sample volume in % of total volume at laboratory: 2

Instrument utilisation (hours per year): 1 500 | *Theoretical max. utilisation:* 2 500

Man years on activity: 0.4[c] | *Staff costs on activity (€):* 18 000

Expenses on service contracts in €/yr: 5 100

Direct costs of activity €/yr (excluding service contracts): 7 000

Additional comments:

[a]) One in 2004, none in 2005

[b]) Measured samples here is counted as recorded hours. Instrument and use of operator is billed by the hour.

[c]) Average 2004-2005: 540 hours (effective)

Testscheme for activity: LA-ICP-MS

Instrumentation, including age, model and make:

Finnigan MAT element (1) double-focusing magnetic sector ICP-MS.

Finnigan 266 nm UV-laser attached.

Both ICP-MS and laser unit was purchased in 1997

Brief description of method and applications (include comment on level of R&D vs. production):

Laser ablation analyses are applied on a variety of sample types, including:

Quartz (investigation of ultra pure qualities)[a]
Zircons and monazite (U-Pb dating)
Fe-Ti oxides, talc etc. for mineral characterisation
Trace element analysis of lithium tetraborate pills (fused disks originally prepared for XRF-major element analysis)[b]
Chemical characterisation of fish shells (provenance issues)

Mineral samples are polished slabs, thick sections or multiple grain mounts, mounted simply under the laser and microscope. Laser ablation techniques have been strongly focused on R&D but have during the most recent years turned more towards production.

Near future investments (planned/expected/required):

Investment in new laser for ICP-MS is necessary but cannot be expected to be approved before 2007. Estimated cost is € 190 000. Investment in new ICP-MS is probably required in a five-year perspective.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A/C

Is the activity wholly or partly accredited?: No

Comment if yes: Analysis of water and acid extracts by ICP-MS is accredited for certain elements whereas analysis by laser ablation is not.

Participation in proficiency testing – number of tests per year for activity: 1

	External contracts	Internal contracts	Total
Number of samples analysed per year[c]:	50	2 700	2 750
Income received per year (€):	4 000	165 000	169 000

Sample volume in % of total volume at laboratory: 4

Instrument utilisation (hours per year)[d] 1500 — *Theoretical max. utilisation:* 1875

Man years on activity[e]: 1.4 — *Staff costs on activity (€):* 70 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 34 000

Additional comments:

[a]) Quartz is routinely analysed for: Li, Be, B, Al, Si, Ge, Rb, Sr, Ba, Pb, U, Mg, P, K, Ca, Ti, Mn, Fe

[b]) Lithium tetraborate discs routinely analysed for REE, U, Th, Y, Zr, Hf, Nb, Ta

[c]) Number of analyses, income and expenditures are averages of 2004 and 2005. Number of actual samples is around 30 external and 2000 internal.

[d]) Estimated 80% capacity of ICP-MS spend with laser ablation

[e]) Assuming that 80% of all man hours recorded on ICP-MS-MS is spend with laser ablation

Testscheme for activity: *Thin section preparation*

Instrumentation, including age, model and make:

The facility is centered around an Astera thin section machine from Artech installed in 2004. The machine was purchased to reduce the manpower requirement in thin section preparation, and is able to both grind and polish up to 32 samples at a time. All actions are computer controlled.

Other equipment for grinding/polishing:
Logitech lapping and polishing machine PM2A and LP30
Struers RotoPol 31 (automated polishing machine)
Various older grinding and polishing machines (GMN, Logitech, Struers)

Brief description of method and applications (include comment on level of R&D vs. production):

Preparation of standard covered and polished thin sections, double polished sections, samples for Ar-Ar. Preparation of polished samples/thick sections for apatite fission track, SEM/LA-ICP-MS and micro drilling.

For thin section preparation samples are sawed and cut into squared pieces. Mounted on glass the samples are usually both grinded and polished on the Astera thin section machine with minimum human interference. Standard thin sections are not polished but covered with laque. There has been an increase in the demand for polished samples and thin sections for use with SEM and LA-ICP-MS.

Preparation of non-standard samples, such as double polished sections, thick sections and polished slabs and bits is also in high demand and remains manpower-intensive.

Near future investments (planned/expected/required): None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	50	1850	1 900
Income received per year (€):	2 500	94 000	96 500

Sample volume in % of total volume at laboratory: 4

Instrument utilisation (hours per year): 250[a]

Theoretical max. utilisation: 1500

Man years on activity: 1.3

Staff costs on activity (€): 65 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 8 000

Additional comments:

[a]) Estimated instrument utilisation is given for Astera thin section machine. Thin section lab is generally running at an estimated two third of full capacity.

Test scheme for activity:	***Grain size distribution***
Instrumentation, including age, model and make:	Coulter LS 200 (0.4-2000µm) from 1996.

Brief description of method and applications (include comment on level of R&D vs. production):

Used for determination of grain size distribution <2000 µm. Fractions lager than 2000 µm determined by sieving & gravimetric measurements.

(Replaced earlier method which was a combination of Sedigraph (0-63 µm) and sieving.)

R&D

Mainly used for production

Near future investments (planned/expected/required):	None
In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C):	C
Is the activity wholly or partly accredited?:	Yes
Comment if yes:	
Participation in proficiency testing – number of tests per year for activity:	1

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year[a]:	120	600	720
Income received per year (€):	9 000	55 000	64 000

Sample volume in % of total volume at laboratory:	1		
Instrument utilisation (hours per year):	500	*Theoretical max. utilisation:*	1500
Man years on activity[b]:	0.3	*Staff costs on activity (€):*	15 000
Expenses on service contracts in €/yr:			900
Direct costs of activity €/yr (excluding service contracts):			2 400

Additional comments:

[a]) Samples and income are averages of 2004 and 2005

[b]) Yearly activity is variable

Testscheme for activity: *Mineral separation*

Instrumentation, including age, model and make:

Two Franz magnetic sepoarators (one old, one purchased late 1990s), one perm roll magnetic separator (10 yrs+), diverse older magnetic equipment

One Fritsch jaw crusher (old) dedicated to separation, Fritsch grinding mill (bought 2000) and one Klöckner-Moeller rolling mill (old)

Wiefling table (old), sieves etc.

Brief description of method and applications (include comment on level of R&D vs. production):

Mineral separation of silicates, oxides, sulphides, volcanic tephra etc. etc.

Recent focus has been on separation of zircon for U-Pb dating, apatite for fission track analysis and K-bearing minerals for Ar-Ar dating. The activity is almost entirely dedicated to production although some hours are spent trying to rationalise separation methods.

The usual process consist of:

1. Sample washing/cleaning, often including sawing
2. Jaw crushing x2, milling x2 (either on grinding mill or on rolling mill) – crushing adjusted to give optimum grain size
3. Sieving (typically 180-150 µm fraction is wanted)
4. Separation on wiefling table
5. Separation of magnetic fractions
6. Heavy liquid separation (tetrabrom-methane, di-iodine-methane, clerisis)

Near future investments (planned/expected/required):

Investment in new wiefling table is necessary in 2006/2007. Expected cost of investment is around € 13000

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	0	185	185
Income received per year (€):	0	95 000	95 000

Sample volume in % of total volume at laboratory: < 1

Instrument utilisation (~~hours per year~~)[a]: 50 %

Theoretical max. utilisation: N.R.

Man years on activity: 1.2

Staff costs on activity (€): 60 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 3 000

Additioonal comments:

[a]) Estimated capacity. Instrument utilisation not relevant

Testscheme for activity: **Analysis of acid extracts, total digestion**

Instrumentation, including age, model and make:

Milestone Microwave MLS 1200 Mega (1996), Exhaust module ES-45/A (2002). 6 position rotor, Teflon bombs

Brief description of method and applications (include comment on level of R&D vs. production):

Only used for "special" applications where partial extract are not sufficient, which is again often related to product control of mineral products.

RD

Approx. 50 %

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*
Number of samples analysed per year:	30	60
Income received per year (€):	1 200	2 400

Sample volume in % of total volume at laboratory: 0.2

Instrument utilisation (hours per year): <50

Theoretical max. utilisation: 1500

Man years on activity: 0

Staff costs on activity (€): 4 500

Expenses on service contracts in €/yr: 1 000

Direct costs of activity €/yr (excluding service contracts): 0

Testscheme for activity: **Analysis of acid extracts, weak leaches**

Instrumentation, including age, model and make:

ICP-OES, GFAAS, CVAAS same as natural water

Brief description of method and applications (include comment on level of R&D vs. production):

Ammonium acetate extraction

At moment seldom used (1-2 project or less pr. year), not used in 2004 and 2005

RD

Approx. 10 %

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	N.R.	N.R.	N.R.
Income received per year (€):	0	0	0

Sample volume in % of total volume at laboratory: 0

Instrument utilisation (hours per year): 0 *Theoretical max. utilisation:* 1500

Man years on activity: 0 *Staff costs on activity (€):* 0

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 0

Testscheme for activity: **Analysis of acid extracts, leachable, compiled**

Instrumentation, including age, model and make:

Extraction autoclave folowed by a variety of instrumental procedures (see following sheets for info on individual methods)

Brief description of method and applications (include comment on level of R&D vs. production):

Includes:

extraction: 3000 samples

ICP-OES: 2790 analyses

GF-AAS: 4000 analyses

CV-AAS: 1620 analyses

HR-ICP-MS: 550 analyses

Near future investments (planned/expected/required):

None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: YES

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: See instruments

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	200	2 800	3 000
Income received per year (€):	22 800	298 000	320 800

Sample volume in % of total volume at laboratory: 19

Instrument utilisation (hours per year): 1500

Theoretical max. utilisation: 2000

Man years on activity: 2.0

Staff costs on activity (€): 100 000

Expenses on service contracts in €/yr: 5 800

Direct costs of activity €/yr (excluding service contracts): 20 100

Testscheme for activity: **Analysis of acid extracts, leachable**

Instrumentation, including age, model and make:

Extraction autoclave.

Folowing extraction a variety of instrumental procedures are available according to customers wish, with regards to element selecton and detection limits. For methods and utilisation of individual instruments with regards to acid extracts, see following sheets. Extraction by autoclave accounts for 98 % of all extractions at NGU-Lab.

Acid extracted samples account for 80 % of liquid samples. Water (primarily natural) accounts for the remaining 20 %.

Brief description of method and applications (include comment on level of R&D vs. production):

Extracts based on autoclave extraction in 7 N HNO_3 (1 gram sample and 20 ml 7 N HNO_3 in autoclave, diluted with distilled water to 100 ml final volume). Follows Norwegian Standard NS 4770.

Extraction is followed by ICP-OES, ICP-MS or selection of available AAS analyses, in any combination according to customers wish.

Near future investments (planned/expected/required): None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: YES

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: See instruments

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	200	2 800	3 000
Income received per year (€):	5 600	69 000	74 600

Sample volume in % of total volume at laboratory: 5

Instrument utilisation (hours per year): 1500

Theoretical max. utilisation: 2000

Man years on activity: 0.6

Staff costs on activity (€): 30 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 3 800

Testscheme for activity: ***Analysis of acid extracts, leachable, ICP-OES***

Instrumentation, including age, model and make:

Perkin Elmer Optima 4300 DV, Scott Spray Chamber, 150 pos sample changer from 2003.
Software : WinLab32 ver. 3.1 (2005)-

Brief description of method and applications (include comment on level of R&D vs. production):

Extracts based on autoclave extraction in 7 N HNO_3 (1 gram sample and 20 ml 7 N HNO_3 in autoclave, diluted with distilled water to 100 ml final volume)

This analysis is regularly used for environmental samples. In some cases also used for product control of mineral products (like limestone) and for analysis of rock.

Routinely used for the determination of Si, Al, Fe, Ti, Mg, Ca, Na, K, Mn, P, Cu, Zn, Pb, Ni, Co, V, Mo, Cd, Cr, Ba, Sr, Zr, Ag, B, Be, Li, Sc, Ce, La, Y, As.. S, Se and Sn also included in method and could be reported on request.

RD

Approx. 10 %

Near future investments (planned/expected/required): No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Yes

Comment if yes: S, Se and Sn not included in accreditation.

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	240	2 550	2 790
Income received per year (€):	9 000	110 000	119 000

Sample volume in % of total volume at laboratory: 5

Instrument utilisation (hours per year): 800 *Theoretical max. utilisation:* 4 800

Man years on activity: 0.9 *Staff costs on activity (€):* 45 000

Expenses on service contracts in €/yr: 5 800

Direct costs of activity €/yr (excluding service contracts): 11 000

Testscheme for activity: Analysis of acid extracts, leachable HR-ICP-MS

Instrumentation, including age, model and make:

Finnigan MAT element (1) double-focusing magnetic sector ICP-MS (1997).

Brief description of method and applications (include comment on level of R&D vs. production):

Extracts based on autoclave extraction in 7 N HNO_3 (1 gram sample and 20 ml 7 N HNO_3 in autoclave, diluted with distilled water to 100 ml final volume)

Mainly back-up for GFAAS&ICP-AES with respect to heavy metals. In some cases also used for a wider spectre of elements like Cd, Pb. V, Cr, Ni, Cu, Zn , As and Se. In addition also used for isotope ratio measurements (mainly Pb)

RD

Approx. 80 %

Near future investments (planned/expected/required):

Investment in new ICP-MS is probably required in a five-year perspective.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: As, Cd, Pb, Se included in accreditation

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	Internal contracts	Total
Number of samples analysed per year:	0	550	550
Income received per year (€):	0	27 000	27 000

Sample volume in % of total volume at laboratory: 0.8

Instrument utilisation (hours per year): 100
(Max =0.5[6000-2000 (laser), Util.= 5% of 1875)]

Theoretical max. utilisation: 2000

Man years on activity: <0.1

Staff costs on activity (€): 3 000

Expenses on service contracts and external service in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 2 000

Testscheme for activity: **Analysis of acid extracts, leachable. GFAAS**

Instrumentation, including age, model and make:

PERKIN ELMER, SIMAA – 6000 (1995)

Brief description of method and applications (include comment on level of R&D vs. production):

Extracts based on autoclave extraction in 7 N HNO_3 (1 gram sample and 20 ml 7 N HNO_3 in autoclave, diluted with distilled water to 100 ml final volume)

This analysis is regularly used for environmental samples. In some cases also used for product control of mineral products (like limestone) and for analysis of rock.

Regularly used for determination of heavy metals: As, Cd, Pb, Se, Sn in lower concentration range.

Zemann correction, Pd used matrix modifier.

RD

Mainly used for production

Near future investments (planned/expected/required):

None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	370	3 600	3 970
Income received per year (€):	6 000	65 000	71 000

Sample volume in % of total volume at laboratory: 7

Instrument utilisation (hours per year): 1300
(assumed 80 % extracts 20% water)

Theoretical max. utilisation: 1920

Man years on activity: 0.4

Staff costs on activity (€): 20 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 2 500

Testscheme for activity: ***Analysis of acid extracts, leachable. Hg-CVAAS***

Instrumentation, including age, model and make:

CETAC M-6000A Mercury Analyzer (1999)

Brief description of method and applications (include comment on level of R&D vs. production):

Extracts based on autoclave extraction in 7 N HNO_3 (1 gram sample and 20 ml 7 N HNO_3 in autoclave, diluted with distilled water to 100 ml final volume)

Regularly used for determination of Hg by cold vapour technique for environmental samples. In some cases also used for product control of mineral products (like limestone) and for analysis of rock.

RD

Mainly used for production

Near future investments (planned/expected/required):

No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 0

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	120	1 500	1 620
Income received per year (€):	2 200	27 000	29 200

Sample volume in % of total volume at laboratory: 3

Instrument utilisation (hours per year): 1300
(assumed 80 % extracts 20% water)

Theoretical max. utilisation: 1920

Man years on activity: 0.1

Staff costs on activity (€): 1 100

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 800

Testscheme for activity:	***Inorganic analysis of water. Compiled***
Instrumentation, including age, model and make:	See following pages

Brief description of method and applications (include comment on level of R&D vs. production):

Inorganic analysis of water by way of a variety of methods. Natural water make up 90 % of all water samples analyses. Methods include ICP-OES, CV-AAS, GF-AAS or HR-ICP-MS, pH, conductivity, colour index, turbidity and alkalinity.

Near future investments (planned/expected/required):	No
In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C):	C
Is the activity wholly or partly accredited?:	Yes
Comment if yes:	
Participation in proficiency testing – number of tests per year for activity:	4

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year[a]*:*	70	700	770
Income received per year (€):	12 000	130 000	142 000

Sample volume in % of total volume at laboratory:	8.2

Instrument utilisation (hours per year): *(assumed 20% use for water, rest extracts)*	200	*Theoretical max. utilisation:*	1200
Man years on activity:	1.1	*Staff costs on activity (€):*	52 000

Expenses on service contracts in €/yr:	5 000
Direct costs of activity €/yr (excluding service contracts):	8 000

Additional comments:

[a]) Number of services are 500 externally and 4 500 internally. The raw number of samples submitted are approximately 70 extarnal and 700 internal. 90 % of all water analyses are natural.

Testscheme for activity:	***Inorganic analysis of water, natural. ICP-OES***
Instrumentation, including age, model and make:	Perkin Elmer Optima 4300 DV, Scott Spray Chamber, 150 pos sample changer from 2003. Software: WinLab32 ver. 3.1 (2005)-

Brief description of method and applications (include comment on level of R&D vs. production):

Water samples are filtered and acidified with HNO_3 prior to ICP analysis. On request filtering and/or acidifying can be performed at the laboratory. Samples with high salinity (> 250 mg Na / l) will normally be diluted.

Routinely used for determination of Si, Al, Fe, Ti, Mg, Ca, Na, K, Mn, P, Cu, Zn, Pb, Ni, Co, V, Mo, Cd, Cr, Ba, Sr, Zr, Ag, B, Be, Li, Sc, Ce, La, Y, Sb, As.

S, Se and Sn also included in method and could be reported on request.

RD

Approx. 10 %

Near future investments (planned/expected/required):	No
In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C):	C
Is the activity wholly or partly accredited?:	Yes
Comment if yes:	S, Se and Sn not included in accreditation.
Participation in proficiency testing – number of tests per year for activity:	4

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	60	650	710
Income received per year (€):	2 300	25 000	27 300

Sample volume in % of total volume at laboratory:	1		
Instrument utilisation (hours per year): *(assumed 20% use for water, rest extracts)*	200	*Theoretical max. utilisation:*	1200
Man years on activity:	0.2	*Staff costs on activity (€):*	10 000
Expenses on service contracts in €/yr:			5 800
Direct costs of activity €/yr (excluding service contracts):			2 750

Testscheme for activity: ***Inorganic analysis of water, natural. HR-ICP-MS***

Instrumentation, including age, model and make: Finnigan MAT element (1) double-focusing magnetic sector ICP-MS (1997).

Brief description of method and applications (include comment on level of R&D vs. production):

Water samples should been filter and acidified with HNO3 prior to ICP analysis. On request filtering and/or acidifying could be done at the laboratory. Samples with high salinity (> 250 mg Na / l) will normally be diluted.

Mainly back-up for GFAAS&ICP-AES with respect to heavy metals. In some cases also used for a wide spectre of elements like :

Y, Nb, Ag, In, Sb, Cs, Nd, Sm, Ho, Yb, Ta, W, Tl, Bi, Th, V, Mn, Cu, Zn, Ga, Ge, Li, Be, B, Rb, Zr, Mo, Cd, La, Ce, Pb, Al, Cr, Co, Ni, U, P, I, K, As, Se

RD

Approx. 80 %

Near future investments (planned/expected/required): Investment in new ICP-MS is probably required in a five-year perspective.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: Al, As, B, Be, Cd, Ce, Co, Cr, La, Mo, Ni, Pb, Rb, Sb, Se included in accreditation

Participation in proficiency testing – number of tests per year for activity: 4

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	0	300	300
Income received per year (€):	0	24 000	24 000

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year)
(Max =0.5[6000-2000 (laser), Util= 15% of 1875)]: 150

Theoretical max. utilisation: 2 000

Man years on activity: < 0.1

Staff costs on activity (€): 2 500

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 1 000

Testscheme for activity: ***Inorganic analysis of water, natural. GFAAS***

Instrumentation, including age, model and make: PERKIN ELMER, SIMAA – 6000 (1995)

Brief description of method and applications (include comment on level of R&D vs. production):

Water samples should been filter and acidified with HNO_3 prior to analysis. On request filtering and/or acidifying could be done at the laboratory.

Regularly used for determination of heavy metals: As, Cd, Pb, Sb, Se, Sn in lower concentration range.

Zemann correction, Pd used matrix modifier.

RD

Mainly used for production

Near future investments (planned/expected/required): No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 4

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	100	900	1 000
Income received per year (€):	1 500	16 000	17 500

Sample volume in % of total volume at laboratory: 2

Instrument utilisation (hours per year): 300
(assumed 80 % extracts 20% water)

Theoretical max. utilisation: 480

Man years on activity: 0.1

Staff costs on activity (€): 5 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 600

Testscheme for activity: ***Inorganic analysis of water, natural. Hg-CVAAS***

Instrumentation, including age, model and make: CETAC M-6000A Mercury Analyzer (1999)

Brief description of method and applications (include comment on level of R&D vs. production):

Water samples should been filter and acidified with HNO_3 prior to analysis. On request filtering and/or acidifying could be done at the laboratory.

Regularly used for determination of Hg by cold vapour technique

RD

Mainly used for production

Near future investments (planned/expected/required): No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 2

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	30	400	430
Income received per year (€):	550	6 800	7 350

Sample volume in % of total volume at laboratory: 0.7

Instrument utilisation (hours per year): 200
(assumed 80 % extracts 20% water)

Theoretical max. utilisation: 480

Man years on activity: < 0.1

Staff costs on activity (€): 300

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 200

Testscheme for activity:	***Inorganic analysis of water, natural. IC***

Instrumentation, including age, model and make:

Dionex DX 120 Ionic Chromatograph. Suppressor :ASRS - ultra 4-mm P/N 53946, Column: Ion Pac AS 14 A 4-mm P/N 56904, Guard column : Ion Pac AG 14 A 4-mm P/N 56897, Software: PeakNet 5.1. Detection : electric conductivity. Gilson sample changer (60 pos.),

All units form 1999.

Brief description of method and applications (include comment on level of R&D vs. production):

Regularly used for determination of 7 anions : F^-, Cl^-, NO_2^-, Br^-, NO_3^-, PO_4^{3-} and SO_4^{2-}

RD

Mainly used for production

Near future investments (planned/expected/required): No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: NO_2^- not included in accreditation

Participation in proficiency testing – number of tests per year for activity: 3

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	100	600	700
Income received per year (€):	4 500	30 000	34 500

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 240 *Theoretical max. utilisation:* 2400

Man years on activity: 0.2 *Staff costs on activity (€):* 10 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 3 000

Testscheme for activity: **_Inorganic analysis of water, natural. Ph, alkalinity, electrical conductivity_**

Instrumentation, including age, model and make:

Radiometer Titralab 94 (80 pos. sample changer-1996, pHC 2701 glass electrode – 1998, CDM 210 conductivity meter - 1996)

Brief description of method and applications (include comment on level of R&D vs. production):

Regularly used for determination of pH, Alkalinity and electrical conductivity.

pH according to Norwegian Standard (NS) method NS 4720, Electric conductivity according to NS-ISO 7888, Alkalinity according to NS 4754..

RD

Mainly used for production

Near future investments (planned/expected/required):

No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 3

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	80	600	680
Income received per year (€):	2 200	20 000	22 200

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 300 *Theoretical max. utilisation:* 2000

Man years on activity: 0.3 *Staff costs on activity (€):* 13 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 400

Testscheme for activity:	***Inorganic analysis of water, natural. Colour number (spectrophotometer)***
Instrumentation, including age, model and make:	Shimadzu UV 1201 spectrophotometer (1993). No sample changer (but 4 cells can be loaded each time)

Brief description of method and applications (include comment on level of R&D vs. production):

Regularly used for determination of colour number.

Method based on earlier Norwegian Standard method NS 4787 (1988)

RD

Mainly used for production

Near future investments (planned/expected/required):	No
In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C):	C
Is the activity wholly or partly accredited?:	Yes
Comment if yes:	
Participation in proficiency testing – number of tests per year for activity:	3

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	65	500	565
Income received per year (€):	500	4 300	4 800

Sample volume in % of total volume at laboratory:	1

Instrument utilisation (hours per year):	200	*Theoretical max. utilisation:*	2000
Man years on activity:	0.1	*Staff costs on activity (€):*	6 000

Expenses on service contracts in €/yr:	750
Direct costs of activity €/yr (excluding service contracts):	150

Testscheme for activity: ***Inorganic analysis of water, natural. Turbidity***

Instrumentation, including age, model and make: Hach 3100A Turbidimeter (1993)

Brief description of method and applications (include comment on level of R&D vs. production):

Regularly used for determination of turbidity in water.

Method based on earlier Norwegian Standard method NS 4723 (1989)

RD

Mainly used for production

Near future investments (planned/expected/required): No

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 2

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	65	500	565
Income received per year (€):	500	4 000	4 500

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 200

Theoretical max. utilisation: 2 000

Man years on activity: 0.1

Staff costs on activity (€): 5 000

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 150

Testscheme for activity: *Inorganic analysis of water, contaminated*

Instrumentation, including age, model and make:

Same instruments as for natural water

Contaminated waters make up about 10 % of all handled water samples

Brief description of method and applications (include comment on level of R&D vs. production):

Water sample can either be analysed with ICP&AAS filtered and acidified or digested (autoclave extracted in 7 N HNO_3). On request also suspended solids could be determined (gravimetric according to NS-ISO Determination of suspended solids. Methods by filtration through membrane filters).

Near future investments (planned/expected/required): None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 1

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	-	-	60
Income received per year (€):	-	-	6 000

Sample volume in % of total volume at laboratory: < 0.1

Instrument utilisation (hours per year): N.R. *Theoretical max. utilisation:* N.R.

Man years on activity: < 0.1 *Staff costs on activity (€):* 3 000

Expenses on service contracts in €/yr: N.R.

Direct costs of activity €/yr (excluding service contracts): N.R.

Testscheme for activity: ***TC, TOC and TS in rocks and sediments***

Instrumentation, including age, model and make: LECO SC-444 (1992)

Brief description of method and applications (include comment on level of R&D vs. production):

Typical samples comprise soils and sediments (marine/non-marine), carbonates etc. etc.

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 1

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	125	2 800	2 925
Income received per year (€):	2 300	70 000	72 300

Sample volume in % of total volume at laboratory: < 1

Instrument utilisation (hours per year): 800 *Theoretical max. utilisation:* 2 000

Man years on activity: 0.5 *Staff costs on activity (€):* 27 000

Expenses on service contracts in €/yr: 3 000

Direct costs of activity €/yr (excluding service contracts): 4 500

Laboratory at Institution (see note 1): **Geological Survey of Finland (GTK)**

Laboratory staff (see note 2)		Number	Average salary		Survey staff
Staff profile:	PhD	7	45000 €	No of PhD	105
	MSc or equivalent	19	32000 €		
	Technical staff	69	19000 €	Total staff at survey	815
	Total staff at lab.	93		FTE	780

Laboratory expenditures (years and €/yr)	Man years	Staff costs	Direct expences
Laboratory total exp. (see note 3)	115	4 139 000 €	2 170 000 €
Investments (see note 4)			500 000 €
R&D	12	500 000 €	
Production	95	3 179 000 €	1 155 000 €
Consumables)			855 000 €
Service contracts(see note 5)			215 000 €
Subcontracts(see note 6)			85 000 €
Administration	8	460 000 €	515 000 €
Management(see note 7)	5	280 000 €	475 000 €
Quality management	1,5	90 000 €	15 000 €
LIMS	1,5	90 000 €	25 000 €
In-house administrative services(see note 8)*	(5)		(180 000 €)
Total labour costs			
Salaries			
Overhead**			

Total turnover at institution (M€/yr) 54 m€

Laboratory earnings (€/yr)(see note 9) External: 2800000€ Internal: 2500000 €

Cost of premises (€)*** 845 890 €

Quality system

Frequency of external audits (specify)	Once/year
Frequency of internal audits (specify)	Once-twice/year
Customer satisfaction: method of assessment, last date or frequency of questionnaires etc. etc.	Questionnaire sent with results to clients at least once a year, quarterly negotiations with in house customers ie. Division Chiefs. General assessment at yearly reviews

*) The figure comes in addition to the (total) regular laboratory administration costs further up. It can probably only be estimated.

**) Salaries refer to money actually paid out. Overhead here should include both social costs (pensions and other benefits) as well as premises, in-house services etc. etc.

***) premises should be calculated as the average rent, heat, electricity, water etc. per area multiplied by the total laboratory area. The figure makes up part of the salary overhead.

General Portfolio

1	X-Ray fluorescence spectrometry (main elements and trace elements)
2	Analysis of total digests for REE and other trace elements by ICP-MS
3	Analysis of precious metals by lead fire assay and ICP-AES, FAAS measurement
4	Analysis of precious metals by agua regia leach, Hg coprecipitation and GFAAS measurement
5	Analysis of platinum group elements by NiS fire assay and ICP-MS measurement
6	Inorganic analysis of rock and soil digests and extracts by ICP-AES
7	Total sulphur, carbon and total inorganic carbon in rocks and sediments
8	Total nitrogen in sediments and peat
9	Organic carbon in sediments and peat
10	Reduced iron (FeII) determination by acid digestion and titration
11	Fluorine deterrmination by fusion and potentiometric measurement
12	Loss of Ignition (LOI) at 1000^{o}C
13	pH, conductivity and alkalinity in waters by automated titration
14	Elemental analysis of waters by ICP-AES and ICP-MS
15	Anions in waters by ion chromatography
16	Phosphate in waters by colorimetry
17	Mercury in waters by CVAAS
18	SEM/EPMA
19	Mineral separation
20	Determination of humus
21	Determination of calorific value
22	Determination of compactibility
23	Determination of water permeability
24	Thin Sectioning Service

Notes

1. Not including mineral processing lab
2. Permanent staff, MSc+ Bsc together, PhD+ Phil.Lic together
3. Total man power years including temporary staff
4. Average investments 2003-2005
5. Including service contracts + maintenance of all equipment, IT-instruments included
6. Professional and analytical services
7. Direct costs include etc. training, cleaning, health care travel expences, which not separated above
8. Not paid out, in house charging as an estimate
9. Internal charging does not cover all activities

Testscheme for activity: **GTK inorganic analysis of water**

Instrumentation, including age, model and make:

1988 Hydrid Generator Varian VGA 76 / GTA -96

1989 IC Dionex System 2000

1995 ICP-MS Perkin Elmer Sciex Elan 6000

1998 ICP- AES Thermo Jarrel Ash IRIS AP / HR DUO

1999 Automatic titrator Mettler

Brief description of method and applications (include comment on level of R&D vs. production):

Methods 138M through 140M (M= ICP-MS) are intended for the determination of concentrations of elements dissolved in water and method 144H for Hg. Method 138M is suitable for household water quality surveys. Method 139M determines a larger selection of elements and is suitable e.g. for natural surface and ground waters. Method 140M is suitable for e.g. rain waters. Method 150M is used for determining acid soluble elements. 150M is a "total analysis" including nitric acid decomposition.

Anions are messured with ion chromatography ,pH and of electrical conductivity.(potentiometry),. (Measurement of groundwater level and depth of observation tube. (Method 85N)

Near future investments (planned/expected/required): Renewal of older ICP-MS equipment. Implementing new methods through EU directives

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Partly

Comment if yes: 90% of the methods are accredited only some special customized applications are outside the scope of accreditation

Participation in proficiency testing – number of tests per year for activity: 5

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	3450	1050	4500
Income received per year (€): a 70 €/s	241500	73500	315 000

Sample volume in % of total volume at laboratory: 3%

Instrument utilisation (hours per year): 8700 *Theoretical max. utilisation:* 15 000

Man years on activity: 6 *Staff costs on activity (€):* 256 000

Expenses on service contracts in €/yr: 1/6 ICP+1/2 M costs 30 000

Direct costs of activity €/yr (excluding service contracts): 73 000

Additional comments:

Aquacheck Proficiency Testing 2003 – 2005

Methods: 140P, 140M, 143I, 143R, 143T, 144H

Distribution	Ca	Mg	Alkalinity	K	Na	Cl	SO4	F	Conduktivity	total P	Ba
245	-0,6	0,38	0,1	-0,72	-0,78	-0,56	-0,83	-1,76	-0,16	-0,15	-0,67
249	-0,38	-0,13	0,03	0,00	-0,09	-0,94	-0,15	-1,28	-0,17	-0,49	0,05
253	-0,42	0,89	-0,21	-0,12	-0,62	-0,8	-0,42	-1,27	-0,06	-0,33	-0,58
261	-0,44	0,46	-0,24	0,11	-0,53	-0,22	-0,12	-1,51	-0,27	-0,83	0,35
269	-0,62	0,76	-0,02	0,03	-0,55	-0,95	0,40	-0,45	0,00	0,12	0,33
273	-0,56	0,42	-0,19	-0,50	-0,43	-0,70	-0,57	-0,60	0,11	< dl	0,55
277	-0,52	-0,27	-0,14	-0,15	-0,53	-0,82	0,04	-1,72	-0,07	0,06	-0,41
281	-1,11	0,28	-0,88	-1,15	-1,50	-0,35	-0,67	**2,51**	0,01	-0,70	0,41
285	-0,50	0,48	0,02	-0,90	-0,52	-1,15	-0,44	**-2,45**	-0,16	0,01	0,76
289	-0,61	0,56	0,32	-0,77	-0,44	-0,72	-0,26	-1,87	0,15	-0,41	0,87
293	-0,45	0,26	0,48	-0,42	**21,1**	-0,78	-0,75	-0,98	0,08	-0,55	0,27

Distribution	Cd	Pb	Ni	Se	As	Sb	Hg	Co	V	Cr	Mo	Sn	Be
245	0,24	0,62	0,09	0,10	-0,06	-0,29	-0,47	0,60	-0,37	-0,21	0,27	-0,50	0,06
249	0,26	0,45	0,00	0,28	0,21	0,42	**2,28**	0,02	0,00	-0,08	0,08	**-9,22**	0,11
253	0,14	0,00	-0,15	0,12	0,60	0,10	-0,56	-0,03	-0,18	-0,54	0,13	1,48	-0,04
261	0,04	0,00	0,00	0,65	0,53	-1,23	1,75	-0,02	-0,39	0,03	0,12	**-4,89**	-0,18
269	0,28	0,47	-0,02	-0,09	0,76	-0,59	-0,61	0,83	0,77	0,42	0,37	**6,47**	0,00
273	0,28	0,61	1,14	0,00	0,36	-0,03	0,28	0,72	0,90	1,35	0,03	-0,03	0,53
277	0,52	0,93	0,97	-0,26	-0,43	-0,90	0,00	-0,05	0,05	0,22	-0,10	0,94	0,00
281	0,02	0,24	0,75	-0,12	0,47	-0,15	-0,57	0,53	0,55	0,43	0,25	**-2,97**	0,16
285	0,42	0,82	0,58	0,21	0,34	-0,28	-0,41	0,90	0,08	0,55	0,31	**-2,60**	-0,06
289	-0,17	0,73	0,52	0,02	0,85	< dl	-0,51	0,14	0,30	-0,06	0,07	**-5,49**	0,84
293	0,08	0,38	-0,60	0,30	1,01	-0,53	-0,50	-0,21	0,20	0,03	0,31	1,69	-0,40

Testscheme for activity: **GTK Analysis of acid extracts (total digestions)**

Instrumentation, including age, model and make:

1990 ICP MS Perkin Elmer Sciex Elan 5000

1989 ICP AES Thermo Jarrel Ash Polyscan 61 E

1998 ICP AES Thermo Jarrel Ash IRIS AP / HR DUO

1991 CEM MDS 2000 Microwave oven

1995 Milestone MLS Microwave oven

various hotplates, shakinng equipment etc

Brief description of method and applications (include comment on level of R&D vs. production):

Petrological analyses i.e. the high precision whole rock analysis including the total analysis of major and minor elements (reported traditionally as oxide percents), analysis of total concentration of trace elements and rare earth elements as well as additional components which are also important for petrological studies – e.g. Loss on Ignition (LOI at 1000C), Fe^{2+}, S, C, H_2O+ or - etc. Major, minor components and REE 's are analysed with multi-element techniques (e.g. ICP-MS) and additional components with element-dedicated methods.

Near future investments (planned/expected/required): Renewal of ICP-AES and MS equipment

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Partly

Comment if yes: >90% of the methods are accredited only some special customized applications are outside the accreditation.

Participation in proficiency testing – number of tests per year for activity: 2

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	1 000	4 000	5000
Income received per year (€):80/s	80 000	320 000	400 000

Sample volume in % of total volume at laboratory: 4 %

Instrument utilisation (hours per year): 3 000

Theoretical max. utilisation: -

*Man years on activity: *)* 5

Staff costs on activity (€): 161 000

Expenses on service contracts in €/yr:1icp+1ms=(12+22)/4 9 000

Direct costs of activity €/yr (excluding service contracts): pretr= 50 +161 211 000

*) Espoo

Z-score values of ICP-AES proficiency testing 2000 - 2005

Geostats; geochem base metal samples

	Geostats 2000_2	Geostats 2001_1	Geostats 2001_2	Geostats 2002_1	Geostats 2002_2	Geostats 2003_1	Geostats 2003_2	Geostats 2004_1	Geostats 2004_2	Geostats 2005_1
AgS1	-1,00	< dl	< dl	< dl	< dl	**-3,00**	0,32	-0,96	< dl	< dl
AgS2	< dl	0,62	< dl	< dl	< dl	1,83	-0,06	-0,78	-1,91	-0,02
AgS3	-1,47	< dl	< dl	**2,44**	< dl	**-3,00**	< dl	0,11	< dl	0,63
AgS4	-1,05	0,13	< dl	-0,05	-1,62	0,24	< dl	-0,08	< dl	1,53
AgS5	-1,16	0,19	**-3,00**	**2,18**	-0,81	-1,74	0,08	< dl	< dl	< dl
AgS6	< dl	0,32	1,73	-1,10	-0,96	**-3,00**	< dl	-0,28	< dl	0,62
AgS7	< dl	-0,82	-0,46	< dl	-1,60	< dl	0,65	**3,00**	< dl	0,82
AgS8	-1,72	**2,78**	< dl	0,70	< dl	**-3,00**	< dl	1,03	< dl	0,19
AgS9	< dl	0,78	**-2,53**	-0,08	0,58	< dl	0,21	1,14	< dl	0,75
AgS10	1,31	0,3	-1,83	1,52	< dl	< dl	0,87	0,91	< dl	< dl
Ag Avg	**-0,85**	**0,54**	**-1,22**	**0,80**	**-0,88**	**-1,67**	**0,35**	**0,45**	**-1,91**	**0,65**
CuS1	0,85	0,27	-0,88	-0,29	0,28	-0,16	1,36	0,16	-0,30	-0,12
CuS2	-0,01	0,38	-0,42	0,3	-0,06	-0,15	-0,09	-1,01	-0,07	-0,19
CuS3	-0,53	0,78	0,16	0,54	0,53	0,03	-0,22	-0,56	0,28	0,06
CuS4	1,03	0,63	-0,67	-0,52	0,05	-0,38	0,19	-0,56	0,27	0,17
CuS5	0,01	-0,02	-0,37	0,19	1,12	0,50	0,78	0,33	0,33	-0,83
CuS6	0,27	0,75	0,64	-0,55	1,87	0,61	0,34	-0,51	0,68	-0,16
CuS7	-0,31	0,24	-0,28	0,00	**2,17**	-0,50	0,78	-0,27	0,44	-0,11
CuS8	-0,97	-0,01	-0,48	-0,86	1,63	0,08	0,05	0,09	-0,32	-0,75
CuS9	-0,03	0,40	0,46	0,24	0,38	-0,22	0,35	0,39	-0,68	0,25
CuS10	**3,00**	0,50	-0,27	1,91	**2,30**	0,31	0,41	0,25	-0,46	-0,39
Cu Avg	**0,33**	**0,39**	**-0,21**	**0,10**	**1,03**	**0,01**	**0,40**	**-0,17**	**0,02**	**-0,21**
PbS1	0,32	0,48	< dl	1,03	< dl	-0,63	0,33	0,68	< dl	-0,54
PbS2	0,89	0,84	-0,30	0,64	< dl	1,94	-0,49	0,38	-0,74	0,78
PbS3	0,40	0,27	-1,17	0,69	-0,18	**2,07**	-0,17	-0,39	0,86	0,36
PbS4	**3,00**	1,52	0,06	0,07	-1,19	-0,82	-0,41	0,62	0,86	0,58
PbS5	1,58	0,14	0,86	1,33	-0,46	-0,01	0,30	0,10	-0,55	< dl

PbS6	0,33	0,27	0,30	0,55	1,26	0,16	0,12	0,21	-0,65	-0,03
PbS7	-0,49	0,35	0,49	-0,48	1,04	0,15	0,51	-0,88	0,07	0,64
PbS8	0,72	0,61	0,91	< dl	0,97	-0,52	-0,6	-0,55	< dl	< dl
PbS9	0,71	0,63	0,68	0,02	-1,31	< dl	1,00	-0,97	0,45	0,42
PbS10	1,82	0,86	0,78	**3,00**	1,60	-0,08	0,35	1,59	-0,56	-0,80
Pb Avg	**0,93**	**0,60**	**0,29**	**0,76**	**0,22**	**0,25**	**0,09**	**0,08**	**-0,03**	**0,18**
ZnS1	0,72	-0,43	-1,40	-1,24	-0,52	-1,08	-1,02	-0,18	-1,04	-0,57
ZnS2	-0,14	-0,1	-1,11	0,45	-1,00	0,29	-0,91	-0,51	-0,86	-1,05
ZnS3	0,38	-0,92	-0,11	-0,87	**2,08**	-0,56	-0,97	-0,3	-0,26	-0,23
ZnS4	-0,36	0,39	-0,88	-1,21	-0,49	-1,23	-1,35	-0,14	-0,30	-0,10
ZnS5	-0,62	-0,1	0,01	0,20	-0,30	-0,09	0,58	-1,11	-1,25	-1,18
ZnS6	-1,03	**-2,38**	**3,00**	-0,38	1,07	-1,20	-0,66	-0,03	-1,19	-0,53
ZnS7	-0,91	-0,74	**3,00**	-0,67	0,93	-0,73	0,63	-0,91	0,56	-0,45
ZnS8	0,35	0,17	0,21	-1,32	0,86	-1,31	-1,05	-1,20	-1,18	-1,08
ZnS9	-0,91	-0,18	0,16	-0,97	-0,60	**-3,00**	-0,04	-1,51	-0,58	-0,55
ZnS10	0,78	0,32	0,56	0,89	-0,59	-0,96	-0,95	0,57	-1,25	-0,95
Zn Agv	**-0,17**	**-0,40**	**0,34**	**-0,51**	**0,14**	**-0,99**	**-0,57**	**-0,53**	**-0,74**	**-0,67**
NiS1	0,58	0,06	-0,65	0,16	-0,22	1,86	-0,04	0,32	-0,79	-0,38
NiS2	0,42	0,64	-0,63	1,20	0,60	1,09	0,24	-0,04	-0,55	-0,95
NiS3	0,61	1,29	-0,05	0,24	0,30	0,25	0,54	-0,02	0,48	0,57
NiS4	0,54	1,49	-0,86	-0,94	0,16	-0,80	-0,03	0,41	0,71	0,77
NiS5	1,41	0,87	-0,87	0,09	0,76	-0,59	0,53	-0,55	-0,45	1,03
NiS6	-0,57	0,54	0,09	0,00	-0,97	0,75	0,23	-0,35	-0,28	-0,35
NiS7	-0,19	0,02	-0,53	-0,07	**3,00**	-1,10	-0,01	-0,03	0,24	0,46
NiS8	0,35	0,62	-0,10	-1,52	-1,08	0,36	-0,54	0,57	-0,69	-1,20
NiS9	0,69	0,32	0,55	0,18	-0,09	**-3,00**	0,03	-1,10	-0,52	1,75
NiS10	0,88	1,03	0,47	0,93	0,72	-0,58	0,53	1,01	0,57	0,65
Ni Avg	**0,47**	**0,69**	**-0,26**	**0,03**	**0,32**	**-0,18**	**0,15**	**0,02**	**-0,13**	**0,24**
AsS1	1,35	3,00	< dl	0,85	< dl	0,11	0,38	0,08	< dl	0,82
AsS2	0,89	0,80	-0,12	0,24	< dl	1,86	0,01	0,19	0,69	< dl
AsS3	0,68	**2,21**	0,90	0,75	< dl	-0,94	-0,28	0,23	0,36	0,91
AsS4	1,06	1,50	< dl	-0,21	0,28	0,38	0,35	0,33	0,53	0,38
AsS5	1,13	0,65	-1,03	1,18	< dl	0,07	0,96	0,05	0,78	0,03
AsS6	0,49	1,67	1,12	0,51	< dl	1,30	-0,67	0,77	0,62	0,87
AsS7	-0,86	< dl	1,20	0,57	< dl	0,57	0,10	-0,45	0,41	0,47
AsS8	-0,30	**-2,46**	1,19	**2,58**	< dl	0,21	0,42	0,49	0,75	< dl
AsS9	**3,00**	1,60	0,15	-0,13	0,16	0,63	0,64	< dl	0,80	0,49
AsS10	**2,07**	-0,07	0,11	**-3,00**	0,22	1,87	0,51	0,63	-0,67	0,88
As Avg	**0,95**	**0,99**	**0,44**	**0,33**	**0,22**	**0,61**	**0,24**	**0,26**	**0,47**	**0,61**
CoS1	0,39	-0,17	0,57	0,09	0,22	0,03	0,23	0,26	-0,99	-0,87

CoS2	-0,23	-0,12	-0,05	0,04	0,41	0,85	-0,67	0,03	-0,95	-0,69
CoS3	0,39	0,11	0,41	0,45	0,69	-0,69	-0,15	0,22	-0,27	-0,89
CoS4	0,01	0,04	-0,9	-0,83	0,30	-0,61	0,15	0,39	-0,24	-0,65
CoS5	0,5	0,73	-0,56	-0,10	-0,17	-0,62	-0,26	0,14	-0,65	-0,72
CoS6	-0,03	0,85	0,16	-1,03	-1,11	0,33	-0,09	-0,02	0,4	-0,63
CoS7	-0,1	-0,16	-1,62	0,03	-0,99	-0,97	-0,89	-0,46	-0,33	-0,58
CoS8	-0,87	0,09	0,38	-1,16	-1,08	0,26	-0,60	0,17	-0,46	-1,05
CoS9	0,62	-0,03	-0,06	0,22	0,07	-1,61	0,35	**3,00**	-0,19	0,09
CoS10	1,27	0,54	0,86	-1,17	1,07	-0,24	-0,07	0,52	-0,39	-0,5
Co Avg	**0,20**	**0,19**	**-0,08**	**-0,35**	**-0,06**	**-0,33**	**-0,20**	**0,43**	**-0,41**	**-0,65**

Testscheme for activity: ***GTK Analysis of acid extracts (excl. total digestions)***

Instrumentation, including age, model and make:

1990 ICP MS Perkin Elmer Sciex Elan 5000

1989 ICP AES Thermo Jarrel Ash Polyscan 61 E

1992 ICP AES Thermo Jarrel Ash Polyscan 61 E

1994 ICP AES Thermo Jarrel Ash IRIS Axial Plasma / upgraded to High Resolution Dual Wiev

1998 ICP AES Thermo Jarrel Ash IRIS AP / HR DUO

1999 ICP AES Thermo Jarrel Ash IRIS Advantage

2001 ICP AES Thermo Jarrel Ash IRIS Advantage

1991 CEM MDS 2000 Microwave oven

1995 Milestone MLS Microwave oven

1998 CEM Mars 5 Microwave oven

2000 CEM Mars 5 Microwave oven

various hotplates, shakinng equipment etc

Brief description of method and applications (include comment on level of R&D vs. production):

For geochemical research and exploration for the base metals aqua regia digestion of the sample (Method 511/510) and multi-element analysis by ICP-AES. Although aqua regia is a powerful leaching agent, it still produces a partial dissolution for many elements. Method 510 is an economic choice. Method 511 gives a large set of elements - however for some elements the results are partial. The data will also give information on alteration and weathering of rock and till samples. In addition to classical geochemical methods, a selection of selective leaches (using enzymes, water extraction, ammonium acetate, pyrophosphate etc.) combined with ICP-MS-analysis is also available for geochemical exploration of buried ore deposits

Nitric acid leach using microwave oven technique, (EPA Method 3051) is used for environmental studies.

Selective leaches for assessment of contamination load on soils and sediments, speciation studies, and chemical properties of soil. Leaches are time controlled (pH control if required). Generally used method is the ammonium acetate leach (method 201), other leaches used are $BaCl_2$ leaches, KCl leach, synthetic rain water leach (pH 4.5), $CaCl_2$ leach, The GTK multielemental ICP-AES methods are mainly based on aqua regia digestion of samples for geochemical research and exploration.For ore grade assays of precious metals ICP-AES is used for anlysing samples after classical Pb fire assay.

In environmental studies selective leaches are used ie. ammonium acetate, pyrophosphate etc followed by with ICP-AES / MS finish

Near future investments (planned/expected/required): Renewal of ICP-AES and MS equipment

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Partly

Comment if yes: >90% of the methods are accredited only some special customized applications are outside the accreditation.

Participation in proficiency testing – number of tests per year for activity: 9

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	82 000	32 000	114000
Income received per year (€):20/s	1 640 000	640 000	2 280 000

Sample volume in % of total volume at laboratory: 91 %

Instrument utilisation (hours per year): 24 000 *Theoretical max. utilisation:* 36 000

*Man years on activity: *)* 31 *Staff costs on activity (€):* 970 000

Expenses on service contracts in €/yr:6icp+1ms=36+22 58 000

Direct costs of activity €/yr (excluding service contracts): pret= 200 000 600 000

*) Espoo 6, Kuo 4, Rov 27, Oku 1. (7 mpy pretreatment included)

Z-score values of ICP-AES proficiency testing 2000 - 2005

Geostats; geochem base metal samples

	Geostats 2000_2	Geostats 2001_1	Geostats 2001_2	Geostats 2002_1	Geostats 2002_2	Geostats 2003_1	Geostats 2003_2	Geostats 2004_1	Geostats 2004_2	Geostats 2005_1
AgS1	-1,00	< dl	< dl	< dl	< dl	**-3,00**	0,32	-0,96	< dl	< dl
AgS2	< dl	0,62	< dl	< dl	< dl	1,83	-0,06	-0,78	-1,91	-0,02
AgS3	-1,47	< dl	< dl	**2,44**	< dl	**-3,00**	< dl	0,11	< dl	0,63
AgS4	-1,05	0,13	< dl	-0,05	-1,62	0,24	< dl	-0,08	< dl	1,53
AgS5	-1,16	0,19	**-3,00**	**2,18**	-0,81	-1,74	0,08	< dl	< dl	< dl
AgS6	< dl	0,32	1,73	-1,10	-0,96	**-3,00**	< dl	-0,28	< dl	0,62
AgS7	< dl	-0,82	-0,46	< dl	-1,60	< dl	0,65	**3,00**	< dl	0,82
AgS8	-1,72	**2,78**	< dl	0,70	< dl	**-3,00**	< dl	1,03	< dl	0,19
AgS9	< dl	0,78	**-2,53**	-0,08	0,58	< dl	0,21	1,14	< dl	0,75
AgS10	1,31	0,3	-1,83	1,52	< dl	< dl	0,87	0,91	< dl	< dl
Ag Avg	**-0,85**	**0,54**	**-1,22**	**0,80**	**-0,88**	**-1,67**	**0,35**	**0,45**	**-1,91**	**0,65**
CuS1	0,85	0,27	-0,88	-0,29	0,28	-0,16	1,36	0,16	-0,30	-0,12
CuS2	-0,01	0,38	-0,42	0,3	-0,06	-0,15	-0,09	-1,01	-0,07	-0,19
CuS3	-0,53	0,78	0,16	0,54	0,53	0,03	-0,22	-0,56	0,28	0,06
CuS4	1,03	0,63	-0,67	-0,52	0,05	-0,38	0,19	-0,56	0,27	0,17
CuS5	0,01	-0,02	-0,37	0,19	1,12	0,50	0,78	0,33	0,33	-0,83
CuS6	0,27	0,75	0,64	-0,55	1,87	0,61	0,34	-0,51	0,68	-0,16
CuS7	-0,31	0,24	-0,28	0,00	**2,17**	-0,50	0,78	-0,27	0,44	-0,11
CuS8	-0,97	-0,01	-0,48	-0,86	1,63	0,08	0,05	0,09	-0,32	-0,75
CuS9	-0,03	0,40	0,46	0,24	0,38	-0,22	0,35	0,39	-0,68	0,25
CuS10	**3,00**	0,50	-0,27	1,91	**2,30**	0,31	0,41	0,25	-0,46	-0,39
Cu Avg	**0,33**	**0,39**	**-0,21**	**0,10**	**1,03**	**0,01**	**0,40**	**-0,17**	**0,02**	**-0,21**
PbS1	0,32	0,48	< dl	1,03	< dl	-0,63	0,33	0,68	< dl	-0,54
PbS2	0,89	0,84	-0,30	0,64	< dl	1,94	-0,49	0,38	-0,74	0,78
PbS3	0,40	0,27	-1,17	0,69	-0,18	**2,07**	-0,17	-0,39	0,86	0,36
PbS4	**3,00**	1,52	0,06	0,07	-1,19	-0,82	-0,41	0,62	0,86	0,58

PbS5	1,58	0,14	0,86	1,33	-0,46	-0,01	0,30	0,10	-0,55	< dl
PbS6	0,33	0,27	0,30	0,55	1,26	0,16	0,12	0,21	-0,65	-0,03
PbS7	-0,49	0,35	0,49	-0,48	1,04	0,15	0,51	-0,88	0,07	0,64
PbS8	0,72	0,61	0,91	< dl	0,97	-0,52	-0,6	-0,55	< dl	< dl
PbS9	0,71	0,63	0,68	0,02	-1,31	< dl	1,00	-0,97	0,45	0,42
PbS10	1,82	0,86	0,78	**3,00**	1,60	-0,08	0,35	1,59	-0,56	-0,80
Pb Avg	**0,93**	**0,60**	**0,29**	**0,76**	**0,22**	**0,25**	**0,09**	**0,08**	**-0,03**	**0,18**
ZnS1	0,72	-0,43	-1,40	-1,24	-0,52	-1,08	-1,02	-0,18	-1,04	-0,57
ZnS2	-0,14	-0,1	-1,11	0,45	-1,00	0,29	-0,91	-0,51	-0,86	-1,05
ZnS3	0,38	-0,92	-0,11	-0,87	**2,08**	-0,56	-0,97	-0,3	-0,26	-0,23
ZnS4	-0,36	0,39	-0,88	-1,21	-0,49	-1,23	-1,35	-0,14	-0,30	-0,10
ZnS5	-0,62	-0,1	0,01	0,20	-0,30	-0,09	0,58	-1,11	-1,25	-1,18
ZnS6	-1,03	**-2,38**	**3,00**	-0,38	1,07	-1,20	-0,66	-0,03	-1,19	-0,53
ZnS7	-0,91	-0,74	**3,00**	-0,67	0,93	-0,73	0,63	-0,91	0,56	-0,45
ZnS8	0,35	0,17	0,21	-1,32	0,86	-1,31	-1,05	-1,20	-1,18	-1,08
ZnS9	-0,91	-0,18	0,16	-0,97	-0,60	**-3,00**	-0,04	-1,51	-0,58	-0,55
ZnS10	0,78	0,32	0,56	0,89	-0,59	-0,96	-0,95	0,57	-1,25	-0,95
Zn Agv	**-0,17**	**-0,40**	**0,34**	**-0,51**	**0,14**	**-0,99**	**-0,57**	**-0,53**	**-0,74**	**-0,67**
NiS1	0,58	0,06	-0,65	0,16	-0,22	1,86	-0,04	0,32	-0,79	-0,38
NiS2	0,42	0,64	-0,63	1,20	0,60	1,09	0,24	-0,04	-0,55	-0,95
NiS3	0,61	1,29	-0,05	0,24	0,30	0,25	0,54	-0,02	0,48	0,57
NiS4	0,54	1,49	-0,86	-0,94	0,16	-0,80	-0,03	0,41	0,71	0,77
NiS5	1,41	0,87	-0,87	0,09	0,76	-0,59	0,53	-0,55	-0,45	1,03
NiS6	-0,57	0,54	0,09	0,00	-0,97	0,75	0,23	-0,35	-0,28	-0,35
NiS7	-0,19	0,02	-0,53	-0,07	**3,00**	-1,10	-0,01	-0,03	0,24	0,46
NiS8	0,35	0,62	-0,10	-1,52	-1,08	0,36	-0,54	0,57	-0,69	-1,20
NiS9	0,69	0,32	0,55	0,18	-0,09	**-3,00**	0,03	-1,10	-0,52	1,75
NiS10	0,88	1,03	0,47	0,93	0,72	-0,58	0,53	1,01	0,57	0,65
Ni Avg	**0,47**	**0,69**	**-0,26**	**0,03**	**0,32**	**-0,18**	**0,15**	**0,02**	**-0,13**	**0,24**
AsS1	1,35	3,00	< dl	0,85	< dl	0,11	0,38	0,08	< dl	0,82
AsS2	0,89	0,80	-0,12	0,24	< dl	1,86	0,01	0,19	0,69	< dl
AsS3	0,68	**2,21**	0,90	0,75	< dl	-0,94	-0,28	0,23	0,36	0,91
AsS4	1,06	1,50	< dl	-0,21	0,28	0,38	0,35	0,33	0,53	0,38
AsS5	1,13	0,65	-1,03	1,18	< dl	0,07	0,96	0,05	0,78	0,03
AsS6	0,49	1,67	1,12	0,51	< dl	1,30	-0,67	0,77	0,62	0,87
AsS7	-0,86	< dl	1,20	0,57	< dl	0,57	0,10	-0,45	0,41	0,47
AsS8	-0,30	**-2,46**	1,19	**2,58**	< dl	0,21	0,42	0,49	0,75	< dl
AsS9	**3,00**	1,60	0,15	-0,13	0,16	0,63	0,64	< dl	0,80	0,49
AsS10	**2,07**	-0,07	0,11	**-3,00**	0,22	1,87	0,51	0,63	-0,67	0,88
As Avg	**0,95**	**0,99**	**0,44**	**0,33**	**0,22**	**0,61**	**0,24**	**0,26**	**0,47**	**0,61**

CoS1	0,39	-0,17	0,57	0,09	0,22	0,03	0,23	0,26	-0,99	-0,87
CoS2	-0,23	-0,12	-0,05	0,04	0,41	0,85	-0,67	0,03	-0,95	-0,69
CoS3	0,39	0,11	0,41	0,45	0,69	-0,69	-0,15	0,22	-0,27	-0,89
CoS4	0,01	0,04	-0,9	-0,83	0,30	-0,61	0,15	0,39	-0,24	-0,65
CoS5	0,5	0,73	-0,56	-0,10	-0,17	-0,62	-0,26	0,14	-0,65	-0,72
CoS6	-0,03	0,85	0,16	-1,03	-1,11	0,33	-0,09	-0,02	0,4	-0,63
CoS7	-0,1	-0,16	-1,62	0,03	-0,99	-0,97	-0,89	-0,46	-0,33	-0,58
CoS8	-0,87	0,09	0,38	-1,16	-1,08	0,26	-0,60	0,17	-0,46	-1,05
CoS9	0,62	-0,03	-0,06	0,22	0,07	-1,61	0,35	**3,00**	-0,19	0,09
CoS10	1,27	0,54	0,86	-1,17	1,07	-0,24	-0,07	0,52	-0,39	-0,5
Co Avg	**0,20**	**0,19**	**-0,08**	**-0,35**	**-0,06**	**-0,33**	**-0,20**	**0,43**	**-0,41**	**-0,65**

Testscheme for activity: ***GTK XRF 2004***

Instrumentation, including age, model and make:

PHILIPS PW 1480/10 1988

PANALYTICAL AXIOS 2004

HERZOG HSM 100P Swing mill 1987 2 pcs

HERZOG HTP 40 Pellet press 1991 2 pcs

Brief description of method and applications (include comment on level of R&D vs. production):

Major, minor and many trace elements are determined by XRF. Determinations are made on pressed powder pellets (Method 175X).

The XRF method is applicable to rocks and soil samples, such as sand, gravel, till and sediments. Technical products and ash of similar composition are also analysed. The prerequisite for applicability of the XRF method is that the chemical composition of the sample remains unchanged during the fine grinding (< 10 μm) as the pressed powder pellet is prepared. Samples containing > 20 % S cannot be analysed by this method. The newest XRF is used in the analysis of mineral process- samples at the pilot plant in Outokumpu.

Near future investments (planned/expected/required): Renewing of the equipment is the most urgent task in the next years. Securing the know how is also essential to maintain the activity in the future.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: Partly

Comment if yes: The whole analysis chain including pretreatment (crushing, pulverizing, pelleting) and XRF analysis (GTK method 175X in Espoo) is accredited.

Participation in proficiency testing – number of tests (samples) per year for activity: 18

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	3400	8000	11400
Income received per year (€):65	221 000	520 00	741 000

Sample volume in % of total volume at laboratory: 7

Instrument utilisation (hours per year): 5000 — *Theoretical max. utilisation:* 7000

Man years on activity: 6 — *Staff costs on activity (€):* 192 000

Expenses on service contracts in €/yr: (2 units) 40 000

Direct costs of activity €/yr (excluding service contracts):(pretr 50 000) 140 000

Additional comments:

Z-score values of XRF proficiency testing 2002-2005										
	SiO2	**TiO2**	**Al2O3**	**Fe2O3T**	**MnO**	**MgO**	**CaO**	**Na2O**	**K2O**	**P2O5**
Scheme										
GeoPT11	**-0,39**	**0,77**	**0,28**	**0,18**	**-0,54**	**-1,58**	**-1,25**	**2,61**	**-0,32**	**0,45**
GeoPT12	**0,64**		**0,87**	**-0,39**	**0,20**	**1,20**	**-0,51**			
GeoPT13	**1,10**	**0,90**	**-0,20**	**0,20**	**0,40**	**0,30**	**0,80**	**0,80**	**0,30**	**-0,10**
GeoPT14	**0,40**		**-0,10**	**-2,00**	**-0,10**		**-0,50**	**0,60**	**-0,60**	
GeoPT15	**0,50**	**0,80**	**0,20**	**0,30**	**-0,20**	**-0,60**	**-0,50**	**1,60**	**-0,20**	**0,70**
GeoPT16	**-0,20**	**0,20**	**2,20**	**-0,90**	**-0,60**	**-0,70**	**-1,00**	**1,80**	**-0,80**	**0,80**
GeoPT17	**1,40**	**1,90**	**1,00**	**-1,30**	**-0,60**	**2,10**	**-0,30**	**1,00**	**-0,20**	

Testscheme for activity: **GTK XRD**

Instrumentation, including age, model and make:

Philips MPD X'Pert, 1996

Philips PW 1730, 1982

Philips PW 1730, 1980

Brief description of method and applications (include comment on level of R&D vs. production):

Qualitative phase identification in powdered samples using manual methods and computer assisted methods (Philips X'Pert High Score , 2004). Semi quantitative analysis of powdered samples using experimentally obtained absorption coefficients and the High Score program. Special emphasis has been put into the identification of clay minerals. Identification of very small samples (< 1 mg) with the Debye-Scherrer method.

Special studies on e.g. the triclinity stage of K-feldspars, plagioclase composition, the crystallinity index of kaolinite and unit cell dimensions.

R&D ~30 %

Internal services ~50 %

Services to external customers ~20 %

Near future investments (planned/expected/required): Renewal of the ICDD reference data base

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 20

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	100	1000	1100
Income received per year (€):	9900	99 000	108 900

Sample volume in % of total volume at laboratory: <1

Instrument utilisation (hours per year): 1400 *Theoretical max. utilisation:* 1560

Man years on activity: 1.5 *Staff costs on activity (€):* 48 000

Expenses on service contracts in €/yr: 10 000

Direct costs of activity €/yr (excluding service contracts): 11 000

Testscheme for activity: **GTK SEM / EPMA**

Instrumentation, including age, model and make:

Scanning Electron Microscope, 6 years, Jeol JSM5900 LV Energy dispersive spectrometer (EDS), 6 years, Oxford Instruments INCA

SEM MLA system FEI Quanta 600 JK Tech Pty + EDAX new.

Electron Microprobe (EPMA), 2 years old , Cameca SX100

Brief description of method and applications (include comment on level of R&D vs. production):

Scanning electron Microscopy (Imaging) of solid materials using SE (secondary electrons), BSE (Backscattered electrons) and elemental analysis and x-ray distribution mapping of elements using EDS

Quantitative analysis of polished solid materials (coated with carbon). Analysis volume ca a cubic micron from exactly defined positions. Elements possible to anlayse: Be – U, with routinely a detection limit of 200 to 2000 ppm.

Qualitative analysis and xray distribution mapping of elements with EDS (energy dispersive spectrometry) or WDS (wavelength dispersive sp.).

Imaging using SE (secondary electrons), BSE (back scattered electrons) or CL (cathodoluminescence)

Trace element analysis with detection limits down to a few ppms

Automatic search of rare phases (U, Au, PGE etc).

The MLA-system is used for modal mineralogy and liberation studies at the Mineralprocessing pilot plant

Near future investments (planned/expected/required):

Updating of the operational system of the Jeol SEM upgradinng of the processor of of the older EDS –system.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: -

	External contracts	Internal contracts	Total
Number of samples analysed per year:	800	1000	1800
Income received per year (€):100	80 000	100 000	180 000

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 5000

Theoretical max. utilisation: 8000

Man years on activity: 5

Staff costs on activity (€): 170 000

Expenses on service contracts in €/yr: 70 000

Direct costs of activity €/yr (excluding service contracts): 100 000

Testscheme for activity: ***GTK Thin section preparation***

Instrumentation, including age, model and make:

Various types mainly > 15 years old

Brief description of method and applications (include comment on level of R&D vs. production):

Polished sections, thin sections and polished thin sections are prepared from drill core and rock samples

Near future investments (planned/expected/required):

Some upgrading of instruments depending of the demand in the future.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): B

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: -

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	972	1100	2072
Income received per year (€): 70	68 000	77 000	145 000

Sample volume in % of total volume at laboratory: <1

Instrument utilisation (hours per year): 3400

Theoretical max. utilisation: 6000

Man years on activity: 4

Staff costs on activity (€): 127 000

Expenses on service contracts in €/yr:

Direct costs of activity €/yr (excluding service contracts): 10500

Testscheme for activity: **GTK Grain size distribution**

Instrumentation, including age, model and make:

Micromeritics Sedigraph 5000D 1987

Micromeritics Sedigraph 5100 1992

Sieving equipment 1989-98

Brief description of method and applications (include comment on level of R&D vs. production):

Particle Size Analysis

The Sedigraph 5100 determines particle size distribution using the sedimentation by measuring particle mass using x-ray absorption and by measuring the rate at which particles fall under gravity through a liquid having known properties as described by Stokes' Law. The smallest diameter of particles reaches up to 0.1 micrometers.

The grain size distribution of coarse fraction (diameter of particles bigger than 63 micrometers) is determined by wet sieving or by dry sieving before Sedigraph analysis

Near future investments (planned/expected/required): 2007: New Instrument for determination of grain size

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?:

Comment if yes: The accreditation of Grain size distribution is intented to get during 2006-2007.

Participation in proficiency testing – number of tests per year for activity:

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	35	1300	1335
Income received per year (€):	3500	130 000	133 500

Sample volume in % of total volume at laboratory: <1

Instrument utilisation (hours per year): 1700 *Theoretical max. utilisation:* 2500

Man years on activity: 3 *Staff costs on activity (€):* 93 000

Expenses on service contracts in €/yr: 2000

Direct costs of activity €/yr (excluding service contracts): 15 000

Testscheme for activity: *GTK Mineral separation*

Instrumentation, including age, model and make:

GTK Modified Knelson 4.5" Concentrator (2001), (several 3" concentrators (1995-2000) in reserve) attached with GTK designed pulp feeder. Manufacturer Knelson Concentrators Ltd, Vancouver, Langley, Canada

Brief description of method and applications (include comment on level of R&D vs. production):

Centrifugal gravity separator. Quantitative separation of heavy minerals d>3.25 and 0,25mm-2.0 mm. Sample material Quaternary sediments or comminuted rock samples. Level of R&D varies, average setting at 15%.

Near future investments (planned/expected/required):

Replacement by the end of 2007, 25,000 Euros

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A*

Is the activity wholly or partly accredited?: no

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 50

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	1000	200	1200*
Income received per year (€):	110 000	22 000	132 000

Sample volume in % of total volume at laboratory: < 1

Instrument utilisation (hours per year): 1200*

Theoretical max. utilisation: 1200*

Man years on activity: 3

Staff costs on activity (€): 93 000.

Expenses on service contracts in €/yr: 2 000

Direct costs of activity €/yr (excluding service contracts): 15 000.

Additional comments:

A will increase, if GTK R&D on other methods fails, otherwise B or C*

1200 in one 8 h shift.*

n.a. n. announced

n.d. not determined due to the fact that laboratory is working with many types of samples. Activity generates 5 to 10 subsamples for further analysis or observing. However, samples volume in% of total is substantial.

Laboratory at Institution: **British Geological Survey (BGS)**

Laboratory staff

	Number	Average salary[1]		Survey staff
Staff profile: *PhD*	26	39 005	*No of PhD*	175
BSc/MSc or equivalent	36[2]	30 667		
Technical staff	23	24 635	*Total staff at survey*	827[4]
Total staff at lab.	85[3]		*FTE*	785

Laboratory expenditures (years and €/yr)

	Person years[5]	Staff costs[6]	Direct expenses
Laboratory total exp.	**44**	**1 877 750**	**1 189 000[7]**
Investments	0	0	507 500[8]
R&D[9]	2.5	116 000	14 500
Production[10]	36.5[11]	1 450 000[11]	638 000
Consumables			*217 500[12]*
Service contracts			*406 000*
Subcontracts			*14 500*
Administration	5.0	311 750	29 000
Management[13]	*4.2*	*253 750*	*8 700*
Quality management[14]	*0.8*	*58 000*	*20 300[15]*
LIMS[16]	-	-	-

Total turnover at institution (M€/yr) 55.1[17]

Laboratory earnings (€/yr)[18] *External[19]:* 1 957 500 *Internal[20]:* 1 232 500

Cost of premises (€) 1 160 000[21]

Quality system

Frequency of external audits (specify)	ISO 17025 – annual; ISO 9001 - biannual
Frequency of internal audits (specify)	ISO 17025 - ~12 pa; ISO 9001 - ~6 pa
Customer satisfaction: method of assessment, last date or frequency of questionnaires etc. etc.	No specific policy on assessing customer satisfaction via use of questionnaires. Feedback (principally, complaints) system in place.

General Information

The BGS has a diverse array of laboratories organised into 22 separate laboratory sections within 7 main disciplines as follows:

Discipline	***Sections***
Analytical Geochemistry	Sample Preparation and Testing Facility* Aqueous Analytical* ICP-AES and ICP-MS* XRFS* Organic and General Chemistry*
Biostratigraphy	Micropaleontology and Palynology
Engineering Geology and Geophysics	Rock Mechanics, Geotechnics and Clay Squeezing Soil Strength Laboratory Geophysics Instrument Development
Groundwater Laboratories (WF)	Groundwater Chemistry* Stable Isotopes and Gas Geochemistry Groundwater Tracers (CFCs and SF_6) Physical Properties
Mineralogy and Petrology	Thin Sections Laboratory* Petrography and Microanalysis* XRD, Thermal Analysis and Clay Mineralogy* Industrial Mineralogy
Radiochemistry and Radiometrics	Radiochemistry Gamma Ray Spectrometry*
Research Laboratories	Hydrothermal and Hydrates Laboratories Microbiology Transport Properties Research

N.B. The Environmental Materials Facility (EMF) and Mobile Environmental Laboratory (MEL) are excluded from the above since neither is fully operational at the time of conducting the benchmarking exercise.

The general testscheme for BGS includes data for the full complement of BGS's laboratories listed above, excluding the EMF and MEL.

The activity testschemes that follow are limited mainly to those analyses and tests identified within the original scope of the benchmarking study, although a few additional activities (testschemes 32 to 37) have also been included. The testschemes cover mainly routine, 'unit-costed' analysis and test activities within the laboratory sections identified with an * in the table above. 'Project-based' laboratory work, especially within the Research Laboratories and Engineering Geology and Geophysics disciplines, are not covered in the activity testschemes.

The data presented in the testschemes represents approximately 70% of the BGS's total laboratory 'volume' (based on a combination of person-years expended and income received per annum).

Notes:

[1] Average salaries are difficult to provide because BGS operates a fluid grading system in which merit promotion is possible from technical grades through to more senior grades. The average values quoted are based on the salary a member of staff would be expected to earn within 3 years of joining BGS at the grade appropriate to their qualifications, assuming that they are not promoted (starting salaries for technical, BSc/MSc and PhD are €19 560, €26 143 and €31 581 respectively). However, most staff would expect to be promoted at least once during their career (the average across BGS is approximately 2.5 promotions per member of staff), meaning that average salaries for a long-term member of staff could well be €7 250 to €14 500 higher than the values quoted.

[2] BSc or equivalent numbers 26; MSc or equivalent numbers 10.

[3] Includes all staff who work in or are associated with laboratory activities, even if peripheral to their main scientific role. The actual number of 'full time' equivalent laboratory staff is difficult to estimate, but is in the region of 44, of which a disproportionate number will have technical rather than PhD and MSc qualifications.

[4] Total staff complement, of which 529 are scientific or technical staff. The full time equivalent staff compliment is 785, of which 513 are classified as scientists.

[5] Person years are based on effective days per year, i.e. excluding weekends, public holidays and annual leave. For BGS, this equates to 212 days or 1590 hours per year.

[6] Staff costs are quoted at cost, i.e. including salaries, pension contributions and national insurance but excluding overheads.

[7] Sum of investments, R&D, production and administration direct costs.

[8] Highly variable since the available funds vary from year to year and laboratory equipment is bid against other BGS investment priorities, but the value quoted is typical of recent average investment in the laboratory capital equipment.

[9] Includes development and validation of methods for accreditation and for supporting general survey science delivery. Does not include development of capability relevant to specific projects or applications, which tends to be funded through core or, very occasionally, commissioned projects.

[10] Production is not easy to define because of the diverse nature of BGS's laboratories and their different modes of function. In general, there are two mechanisms of delivery: 'internal service' and 'project', although some labs may perform under either mode depending on circumstances. The 'service delivery' component is delivered through defined 'internal service' laboratories, which include: sample preparation, thin section preparation, micropalentology, XRFS, groundwater chemistry, ICP, aqueous analytical and organic and general chemistry. Other laboratories (including aquifer properties, geotechnical, clay squeezing, mineralogy and petrology, radiochemistry, geomicrobiology, hydrothermal and transport properties) tend to work on a 'project' basis

[11] Staff effort and costs for production are very difficult to estimate because of the diverse nature of BGS's laboratories and the different modes of function. The 'service delivery' component, is easier to estimate and comprises approximately 22 man years' effort at a cost of €797 500. The effort and cost of carrying out laboratory work on a 'project' basis is much more difficult to estimate since it is not easy to differentiate between laboratory and non laboratory-based activities (such as interpretation), but is thought to be in the region of 15 man years at a cost of €652 500.

[12] Estimate only. Consumable costs associated with 'service delivery' equates to approximately €116 000 pa. Non-service delivery is via projects, and is much more difficult to attribute, but has been estimated to be €101 500.

[13] Includes the Laboratory Operations Manager (LOM), management time for all Section and Laboratory Managers, and secretarial and administrative support.

[14] Includes the UKAS Quality Manager and QA administrative support, but not time spent on 'routine' QA and QC activities within the laboratories that are considered to be part and parcel of the analysis.

[15] Includes fees fro UKAS ISO 17025 accreditation and for participation in proficiency testing schemes.

[16] Costs for LIMS are not included as the system is currently under development.

[17] Turnover includes both core (SB) funding from NERC and commissioned (CR) income. The distribution of SB and CR varies annually, but the CR component typically various from 45 to 65% of the total turnover. The value of €55.1m excludes ~€5.8m capital and infrastructure funds.

[18] The 'Internal service' component of the income equation is relatively easy to estimate, and equates to approximately €1.16m pa, of which about €652.5k is internal and €507.5k external. For the reasons described in [10] above, 'project' income directly related to laboratory activities is much more difficult to estimate, but is thought to be in the order of €2.03m, of which about €1.45m is external and €0.58m internal.

[19] External income includes both project income at value (i.e. including appropriate OHs charged to the customer) and internal service income derived from both internal sources (BGS CR projects) and through direct commissions instigated by the laboratories.

[20] Internal income includes both project and internal service income.

[21] Figure provided is a gross estimate based on approximate values for energy and water consumption and the proportion of total site rent based on the area of laboratories compared to total area.

General Portfolio

1	Analysis of waters (compiled from portfolio items 2 to 15)
2	pH and alkalinity in waters by automated titration – 1
3	Alkalinity in waters by potentiometric titration – 2
4	Cations in waters by ICP-AES – 1
5	Cations in waters by ICP-AES – 2
6	Cations in waters by ICP-AES – 3
7	Inorganic analysis of metals in water by ICP-MS
8	Anions in waters by ion chromatography – 1
9	Anions in waters by ion chromatography – 2
10	Total organic and inorganic carbon in waters - 1
11	Organic carbon in waters – 2
12	Reduced iron (FeII) in waters by UV absorbance
13	Total iodine in water by segmented flow colorimetry
14	N species in water by segmented flow colorimetry
15	Mercury in solids and waters by AFS
16	Analysis of total digests (compiled from portfolio items 17 to 19)
17	Inorganic analysis of rock and soil digests and extracts by ICP-AES
18	Inorganic analysis of dissolved solids by ICP-MS
19	Analysis of acid extracts: total digests and physiologically based weak leaches by ICP-AES
20	Total carbon and total inorganic carbon in sediments
21	XRFS sample preparation
22	X-Ray fluorescence spectrometry
23	XRD sample preparation
24	X-ray diffraction (XRD)
25	Scanning electron microscope (SEM) Analysis
26	Electron microprobe analysis (EPMA)
27	Laser ablation ICP-MS
28	Thin Sectioning Service
29	Grain size determination
30	Grain Size Distribution
31	Mineral Separation
32	Determination of pH in soils by $CaCl_2$ slurry method
33	Determination of LoI @ 450^{o}C
34	PAHs in soils and waters using HPLC
35	PCBs in sediments by GCMS
36	Total Petroleum Hydrocarbons in sediments and soils
37	Gamma ray spectrometry

Testscheme for activity 1: ***Analysis of waters (compiled)***

Instrumentation, including age, model and make: See individual activities 2 to 15

Brief description of method and applications (include comment on level of R&D vs. production):

Compilation of activities 2 to 15, summarising all data relating to the analysis of waters.

Includes data for pH and alkalinity, ICP-AES, ICP-MS, ion chromatography, TOC, reduced Fe, iodine, N species and Hg.

Near future investments (planned/expected/required): N/A

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: see individual activities

Participation in proficiency testing – number of tests per year for activity: see individual activities

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	1000	3000	4000
Income received per year (€):	116000	232000	348000

Sample volume in % of total volume at laboratory: 13

Instrument utilisation (hours per year): see individual activities

Theoretical max. utilisation: see individual activities

Man years on activity: 4.10

Staff costs on activity (€): 171000

Expenses on service contracts in €/yr: see individual activities

Direct costs of activity €/yr (excluding service contracts): see individual activities

Test scheme for activity 2: ***pH and alkalinity in waters by automated titration - 1***

Instrumentation, including age, model and make:

Radiometer TIM 865 TitraLab and TitraMaster 85 Data Collector; approximately 18 months old.

Brief description of method and applications (include comment on level of R&D vs. production):

Alkalinity and pH are determined by automated potentiometric titration, with dilute H_2SO_4, of (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates[1].

We offer immediate turnaround for many hydrothermal samples because of their unstable nature.

Alkalinity speciation is calculated using a series of validated, verified mathematical relationships.

Following the recent validation and accreditation of the TIM 865 instrument, throughput is ~100% production.

Near future investments (planned/expected/required): None anticpated

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C/A

Is the activity wholly or partly accredited?: Yes

Comment if yes: The standard method for determination of total alkalinity is UKAS accredited. Samples having pH <4 or >10 fall outside the scope of accreditation. Determination of alkalinity speciation (hydroxide, carbonate and bicarbonate) is outside the scope of accreditation.

Participation in proficiency testing – number of tests per year for activity: 10

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	350	650	1000
Income received per year (€):	4600	8600	13200

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 350 *Theoretical max. utilisation:* 1500

Man years on activity: 0.2 *Staff costs on activity (€):* 7300

Expenses on service contracts in €/yr: 730

Direct costs of activity €/yr (excluding service contracts): 580

Additional Comments

[1] The breakdown in effort between (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates is approximately 1:5.

Testscheme for activity 3: **Alkalinity in waters by potentiometric titration - 2**

Instrumentation, including age, model and make:
Radiometer TIM860 single-burette autotitrator, 2002

Brief description of method and applications (include comment on level of R&D vs. production):

Routine analysis of alkalinity in groundwater. Cornerstone of lab data QA system because used for ion balance calculation on most samples.

Optimised to handle small volume samples, usually 1 mL.

Often used in conjunction with core processing and centrifuging to analyse samples immediately on recovery of pore water, as alkalinity unstable parameter, especially in calcite waters. Sometimes used in this capacity off site by setting up equipment in temporary field lab.

Near future investments (planned/expected/required):
Transfer from paper output to PC control would be desirable – software approx €2200.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 5

	External contracts	Internal contracts	Total
Number of samples analysed per year:	400	400	800
Income received per year (€):	3200	6500	9700

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 400 *Theoretical max. utilisation:* 2000

Man years on activity: 0.2 *Staff costs on activity (€):* 6500

Expenses on service contracts in €/yr: 510

Direct costs of activity €/yr (excluding service contracts): 290

Test scheme for activity 4: ***Cations in waters by ICP-AES - 1***

Instrumentation, including age, model and make:

Varian Vista Axial Pro Inductively Coupled Plasma-Atomic Emission Spectrometer.

Approximately 7 years old.

Brief description of method and applications (include comment on level of R&D vs. production):

Determination of major and trace cations, typically Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sr, V and Zn in (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates[1].

Other elements may be determined at the customer's request. The standard method is applied to aqueous samples and experimental solutions that have been (ideally) filtered and acidified. The instrument is pre-calibrated using suitably matrix-matched, multi-element standards covering the expected concentration ranges. Sample consumption is low, typically 3 ml, although sample volumes of less than 1.0 ml have been run successfully on this instrument.

The instrument has separate glassware (i.e. nebuliser, spray chamber and torch) configurations for the determination of cations in waters, and for digests and leaches of rocks and soils.

The current level of R&D is about 30% of the time spent on the waters configuration.

Near future investments (planned/expected/required):

Validation and accreditation of new methods. A replacement ICP-AES is scheduled for 2006-07.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: Method is UKAS accredited, although K, Co and B are currently outside the scope of accreditation.

Participation in proficiency testing – number of tests per year for activity: 15

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	350	650	1000
Income received per year (€):	17500	33400	50900

Sample volume in % of total volume at laboratory: 1.5

Instrument utilisation (hours per year): 800

Theoretical max. utilisation: 3000[2]

Man years on activity: 0.25

Staff costs on activity (€): 13600

Expenses on service contracts in €/yr: 9700[2]

Direct costs of activity €/yr (excluding service contracts): 8400

Additional Comments

[1] The breakdown in effort between (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates is approximately 1:6.

[2] The instrumentation is also used for the analysis of acid extracts – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts are given as totals for the instrument.

Testscheme for activity 5: Cations in water by ICP-AES - 2

Instrumentation, including age, model and make:

Perkin-Elmer Optima 3300 DV, purchased 1998.

Shared use instrument owned jointly by BGS and CEH.

Brief description of method and applications (include comment on level of R&D vs. production):

Analysis for suite of 27 elements: Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Si, S, Sr, V, Y, Zn.

Direct aspiration of natural water samples, mostly groundwaters, in 1% HNO3 matrix. Small volume samples. One of core routine analytical procedures for the groundwater lab.

Also sometimes analysis of aqueous leaches carried out on aquifer or sediment materials. This work higher R&D component, often related to lab experimental studies.

Also occasional use with hydride-generation for e.g As. Less common now due to availability of AFS.

Near future investments (planned/expected/required): None anticipated.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 5

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	450	800	1250
Income received per year (€):	16000	32000	48000

Sample volume in % of total volume at laboratory: 1.5

Instrument utilisation (hours per year): 1000 *Theoretical max. utilisation:* 3000

Man years on activity: 0.4 *Staff costs on activity (€):* 17400

Expenses on service contracts in €/yr: 16000

Direct costs of activity €/yr (excluding service contracts): 8700

Testscheme for activity 6: **Cations in waters by ICP-AES - 3**

Instrumentation, including age, model and make:

ICP-AES, Fisons/ARL 3580 simultaneous/sequential spectrometer, approximately 16 years old.

Brief description of method and applications (include comment on level of R&D vs. production):

Determination of major and trace cations – Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Si, total S, Sr, Ti, V, Y, Zn and Zr in natural, waste and synthetic waters. The UKAS accredited method (AGN 2.3.1) covers the analysis of waters for all elements except As and Ti.

Virtually all samples are natural waters of varying salinities, with GBASE, the BGS's national geochemical survey, being the largest client.

Near future investments (planned/expected/required):

A replacement ICP-AES is scheduled for 2006

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: The method is accredited for waters analysis for all elements listed except As and Ti.

Participation in proficiency testing – number of tests per year for activity: 15

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	130	1000	1130
Income received per year (€):	5100	25000	30100

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 600

Theoretical max. utilisation: 2500[1], [2]

Man years on activity: 0.45

Staff costs on activity (€): 14500

Expenses on service contracts in €/yr: 12300[2]

Direct costs of activity €/yr (excluding service contracts): 5100[2]

Additional Comments

[1] The theoretical maximum number of hours is limited by the size of the current autosampler, i.e. any run is limited to approximately 10 hours.

[2] The instrumentation is also used for the analysis of acid extracts – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts and other direct costs are given as totals for the instrument. The split between waters and rocks is approximately 70:30 in terms of number of samples.

Testscheme for activity 7: *Inorganic analysis of metals in water by ICP-MS*

Instrumentation, including age, model and make:

VG ExCell ICP-MS instrument, with collision cell. Instrument delivery accepted in March 2000.

Brief description of method and applications (include comment on level of R&D vs. production):

(i) Determination of elemental concentrations in waters

Analysis of natural waters, usually surface, groundwaters and porewaters, covering a wide range of salinities. Elements accredited are Li, Be, Al, V, Cr, Mn, Co, Ni, Cu, As, Sr, Mo, Cd, Sb, Ba, Tl and Pb, although many other elements are determined at the request of the clients. The capability includes elements that cannot be determined by ICP-AES or provides better detection limits.

Methodology involves addition of internal standard via a T-piece and calibration against traceable aqueous standards.

Main client is GBASE – 500-600 samples p.a. at present.

(ii) Determination of U and Pb isotope ratios in waters

Methodology involves chemical separation and preconcentration on ion-exchange columns prior to isotope ratio measurements by ICP-MS. Most of the U isotope work is commercial or CR whereas the small amount of Pb isotope work is for SB projects.

(iii) R&D programme

(1) Arsenic, selenium and chromium species in water using on-line and off-line separation and preconcentration prior to determination by ICP-MS; (2) Isotope dilution studies; (3) PhD studies. (see Inorganic analysis of dissolved solids by ICP-MS)

Other lab activities include training of overseas visitors, etc.

Near future investments (planned/expected/required):

Purchase of HPLC to couple to ICP-MS instrument for research into arsenic speciation (and other elements). Replacement autosampler has been put on list of minor capital items.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Partly accredited

Comment if yes: The analysis of waters is UKAS accredited for 17 elements but could be extended to cover more.

Participation in proficiency testing – number of tests per year for activity: 5 clean Aquachecks

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	170	800	970
Income received per year (€):	29000	29000	58000

Sample volume in % of total volume at laboratory: 2.5

Instrument utilisation (hours per year): 1000[1]

Theoretical max. utilisation: 3750[2], [3]

Man years on activity: 0.8[1]

Staff costs on activity (€): 42000

Expenses on service contracts in €/yr: 11000[2]

Direct costs of activity €/yr (excluding service contracts): 8700

Additional Comments

[1] No account has been taken of the number of samples or income from R&D activities and other lab based activities, such as training of visitors. However, the instrument utilisation and direct costs do cover these extra activities to a large extent. Maintenance of capability and other SB funding for this FY would amount to at least 10 SSO days, 25 HSO days, 40 SO days and 40 student days spread over water and digested solids by ICP-MS (equivalent to €23000 at basic rates) plus associated internal services where relevant.

[2] The instrumentation is also used for the analysis of acid extracts – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts and direct costs are given as totals for the instrument. The combined amount for the analysis of waters and dissolved solids, including sample dissolution, separation and preconcentration (where applicable), cones, torches, standards, bottles, acids, etc., is €22000k. The service contract for the PQ ExCell is €11000.

[3] Theoretical maximum utilisation is based on 15 hours, 5 days a week, for 50 weeks a year – this assumes that the utilisation is not limited by the availability of suitably qualified staff, which is not always the case. Also, no account has been taken of times when unattended operation is not possible, e.g. HLPC coupling, which requires continuous operator attendance. Instrument utilisation does not include any downtime or maintenance. Also, it should be noted that because of the large variety of materials analysed by ICP-MS, frequently it is not possible to analyse all sample types by the same methodology and time may be required between runs to clean and re-set the instrument. This is especially true for analysis such as isotope ratio measurements, GBASE waters and HPLC coupling, where achieving the instrument performance demanded by the customer requires time and skilled operators.

Test scheme for activity 8: **Anions in waters by ion chromatography - 1**

Instrumentation, including age, model and make: Dionex DX-600 Ion Chromatograph; approximately 4 years old

Brief description of method and applications (include comment on level of R&D vs. production):

Determination of major and trace anions; F^-, Cl^-, NO_2^-, Br^-, NO_3^-, HPO_4^{2-} and SO_4^{2-}, by electrochemical and UV absorbance detection in (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates[1]. S_2O_3 can also be determined upon request by the client.

The technique uses standard ion chromatography methodology for the separation of these anions.

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: All determinands listed above, with the exception of thiosulphate, fall within the scope of UKAS accreditation, which was gained in 2004.

Participation in proficiency testing – number of tests per year for activity: 10

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	350	1100	1450
Income received per year (€):	13000	36500	49500

Sample volume in % of total volume at laboratory: 1.5

Instrument utilisation (hours per year): 1600

Theoretical max. utilisation: 6000[2]

Man years on activity: 0.4

Staff costs on activity (€): 17500

Expenses on service contracts in €/yr: 5800[2]

Direct costs of activity €/yr (excluding service contracts): 5000

Additional Comments

[1] The breakdown in effort between (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates is approximately 10:1.

[2] The instrumentation is also used for the analysis of reduced iron, Fe(II), in waters – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts are given as totals for the instrument.

Testscheme for activity 9: *Anions in water by Ion Chromatography - 2*

Instrumentation, including age, model and make:

Dionex DX-500, ECD detector, purchased 2000

Shared use instrument, owned by CEH, but used by BGS. BGS pay share of consumable costs (e.g. replacement columns).

Brief description of method and applications (include comment on level of R&D vs. production):

Analysis of major and halide anions (F, Cl. Br, NO3, SO4 and sometimes PO4) in natural waters, especially groundwaters. Small volume samples).

We also have working method for bromate (which can also be used for other oxyhalides, chlorate etc). Method was developed in conjunction with major CR bid in which bromate analysis was key requirement. Bid subsequently lost.

Near future investments (planned/expected/required):

None planned or essential, although UV detector could provide additional functionality and sensitivity.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 5

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	350	650	1000
Income received per year (€):	8700	16000	24700

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 1200

Theoretical max. utilisation: 3000

Man years on activity: 0.4

Staff costs on activity (€): 12800

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 1800

Test scheme for activity 10: ***Total organic and inorganic carbon in waters***

Instrumentation, including age, model and make:

Shimadzu TOC 5000 analyser; approximately 15 years old

Shimadzu TOC-V CPH analyser; approximately 18 months old

Brief description of method and applications (include comment on level of R&D vs. production):

The UKAS accredited method is applied to the determination of TOC, DOC, NPOC or TIC in (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates[1].

Total carbon (TC) and non-purgeable organic carbon (NPOC) are determined by combustion to carbon dioxide, which is measured using a non-dispersive infra-red (NDIR) gas analysis system. Total inorganic carbon (TIC) is determined by acid liberation of carbon dioxide with similar detection. Total organic carbon (TOC) or dissolved organic carbon (DOC) are calculated by difference (TC-TIC). NPOC involves the removal of TIC by acidification and sparging prior to analysis and is a direct measurement of organic carbon content.

Currently, these are run on the 5000 instrument for which no R&D work is either current or planned. Validation work to bring the TOC-V CPH into service and gain UKAS accreditation for the TIC/TOC and NPOC methods is ongoing.

Near future investments (planned/expected/required): Staff time for validation and accreditation, but no further investment in instrumentation.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: Method is UKAS accredited

Participation in proficiency testing – number of tests per year for activity: 10

	External contracts	*Internal contracts*	*Totals*
Number of samples analysed per year:	150	1000	1150
Income received per year (€):	2200	14500	16700

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 1200 *Theoretical max. utilisation:* 5000

Man years on activity: 0.15 *Staff costs on activity (€):* 6500

Expenses on service contracts in €/yr: 1800

Direct costs of activity €/yr (excluding service contracts): 600

Additional Comments

[1] The breakdown in effort between (a) natural waters, including low volume pore-waters, hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates is approximately 10:1.

Testscheme for activity 11: ***Organic carbon in waters - 2***

Instrumentation, including age, model and make:

Analytical Sciences Thermalox

Shared use instrument owned by CEH

Brief description of method and applications (include comment on level of R&D vs. production):

Analysis of OC in waters – pre-sparge followed by furnace combustion and IR detection.

Equipment capable of TC/TOC/TIC/NPOC as appropriate; usually used for DOC/NPOC

NB. Also used for TDN. Figures given below relate to carbon only
TDN workload more variable depending on project – on average perhaps half that for NPOC.

Near future investments (planned/expected/required): Minor maintenance and consumables only

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: AWMN x 4

	External contracts	*Internal contracts*	*Totals*
Number of samples analysed per year:	150	250	400
Income received per year (€):	2600	4400	7000

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 400 *Theoretical max. utilisation:* 800

Man years on activity: 0.15 *Staff costs on activity (€):* 8300

Expenses on service contracts in €/yr: 0

Direct costs of activity €/yr (excluding service contracts): 300

Test scheme for activity 12: **Reduced iron (FeII) in waters by UV absorbance**

Instrumentation, including age, model and make:

UV absorbance

Dionex DX-600 Ion Chromatograph; approximately 4 years old.

Brief description of method and applications (include comment on level of R&D vs. production):

Determination of the reduced form of iron Fe(II) by UV absorbance detection in (a) natural waters, including hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates[1].

The technique uses standard ion chromatography instrumentation adapted for the analysis, essentially, the columns and suppressor are removed, turning the instrument in to a flow through UV/vis spectrometer.

Near future investments (planned/expected/required): None anticipated.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes: Method gained full UKAS accreditation in 2005

Participation in proficiency testing – number of tests per year for activity: 5

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	200	100	300
Income received per year (€):	2300	1200	3500

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 150

Theoretical max. utilisation: 6000[2]

Man years on activity: 0.05

Staff costs on activity (€): 2200

Expenses on service contracts in €/yr: 5800[2]

Direct costs of activity €/yr (excluding service contracts): 300

Additional Comments

[1] The breakdown in effort between (a) natural waters, including hydrothermal fluids and saline waters, and (b) waste waters including synthetic or experimental fluids, hypersaline fluids and aqueous leachates is approximately 1:2.

[2] The instrumentation is predominantly used for the analysis of anions in waters – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts are given as totals for the instrument.

Testscheme for activity 13: **Total iodine in water by segmented flow colorimetry**

Instrumentation, including age, model and make:

Bran & Luebbe AA3 dual-channel continuous segmented flow analyzer, purchased 2000.

Shared use instrument, used also by CEH

Brief description of method and applications (include comment on level of R&D vs. production):

Analysis of total iodine (often as surrogate for iodide) in natural waters, especially groundwaters. Small volume samples (< 2 mL).

Inverse colorimetric method where iodine causes loss of colour due to catalytically enhanced reduction of cerium colour agent.

Valuable method because iodine difficult or impossible to measure effectively at low concentrations by other techniques e.g ICP-OES, ICP-MS, IC. Analysis possible using ICP-MS but often requires pre-treatment and conditions re-optimised, so loses multi-element capacity of ICP.

Used as routine method but some development work continuing. Method well established, but following provision of new equipment, calibration ranges and sensitivities are currently being reviewed. Discussions with technical support staff from manufacturer.

Near future investments (planned/expected/required): Maintenance only

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: No

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	150	250	400
Income received per year (€):	2600	4400	4800

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 300 *Theoretical max. utilisation:* 2000

Man years on activity: 0.15 *Staff costs on activity (€):* 5000

Expenses on service contracts in €/yr: 2300

Direct costs of activity €/yr (excluding service contracts): 500

Testscheme for activity 14: *N species in water by segmented flow colorimetry*

Instrumentation, including age, model and make:

Skalar SAN 4-channel continuous segmented flow analyzer, purchased 2001

Brief description of method and applications (include comment on level of R&D vs. production):

Analysis for TON, NO2 and NH4.

Application of 3 classical continuous flow chemistries (e.g Technicon) for determination of ug/L quantities of NH4 and NO2, 0.1 mg/L of TON in groundwaters.

Routine method, now well established. Only analytical R&D component is evaluation of alternative calibration ranges. However analysis sometimes used interactively with project staff, providing rapid analysis to refine sampling intervals and frequencies during core processing.

Near future investments (planned/expected/required):

None anticipated

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 5

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	400	700	1100
Income received per year (€):	8700	17400	26100

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 800

Theoretical max. utilisation: 2000

Man years on activity: 0.4

Staff costs on activity (€): 14500

Expenses on service contracts in €/yr: 1100

Direct costs of activity €/yr (excluding service contracts): 1100

Testscheme for activity 15: ***Mercury in solids and waters by AFS***

Instrumentation, including age, model and make:

Atomic Fluorescence Spectrometer from PS Analytical Ltd.

Purchased as new in November 04.

Model: Millennium Merlin.

Brief description of method and applications (include comment on level of R&D vs. production):

Scope: Analysis of geological and related solid materials.

Method: Samples are digested in a 1:1 aqua-regia : water mix. The resulting solution is analysed by AFS.

Scope: Analysis of natural waters and other aqueous solutions.

Method: Samples are stabilised on collection by the addition of $HNO_3/K_2Cr_2O_7$ solution. Prior to analysis samples are treated with a brominating solution to allow Hg to be determined as 'total' Hg.

Near future investments (planned/expected/required): None anticipated

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes:

The procedure for the analysis of Hg on solid samples is accredited for both UKAS and MCERTS.

The procedure for the analysis of "total" Hg in waters is to be put forward for accreditation in the coming year.

Participation in proficiency testing – number of tests per year for activity: 20

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	180	100	280
Income received per year (€):	7300	3000	10300

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 250[1]

Theoretical max. utilisation: 1600

Man years on activity: 0.25

Staff costs on activity (€): 9400

Expenses on service contracts in €/yr: 6000

Direct costs of activity €/yr (excluding service contracts): 600

Additional Comments

[1] Although the instrument time appears low in comparison to staff costs and man years, the latter two items include preparation and digestion of samples prior to analysis.

Testscheme for activity 16: **Analysis of total digests (compiled)**

Instrumentation, including age, model and make:

ICP-AES, Fisons/ARL 3580 ICP-AES – see activity 17

VG ExCell ICP-MS – see activity 18

Varian Vista Axial Pro ICP-AES – see activity 19

Brief description of method and applications (include comment on level of R&D vs. production):

Compilation of activities 17 and 18 and 19, summarising data relating only to total mixed acid digest of soils and rocks.

Data quoted include effort, income and expenditure related to carrying out the acid digest as well as for the analysis.

Near future investments (planned/expected/required): N/A

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: see individual activities

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	2700	530	3230
Income received per year (€):	113000	29000	142000

Sample volume in % of total volume at laboratory: 5.5

Instrument utilisation (hours per year): see individual activities

Theoretical max. utilisation: see individual activities

Man years on activity: 1.90

Staff costs on activity (€): 91000

Expenses on service contracts in €/yr: see individual activities

Direct costs of activity €/yr (excluding service contracts): see individual activities

Testscheme for activity 17: ***Inorganic analysis of rock and soil digests and extracts by ICP-AES***

Instrumentation, including age, model and make:

ICP-AES, Fisons/ARL 3580 simultaneous/sequential spectrometer, approximately 16 years old.

Brief description of method and applications (include comment on level of R&D vs. production):

Determination of major and trace cations – Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Si, total S, Sc, Sr, Ti, V, Y, Zn and Zr in rock and soil digests and extracts.

The method also includes sample dissolution using HF mixed acid attacks, sodium peroxide fusions or microwave nitric acid digests for biological materials. The majority of samples require a total digest; partial leaches make up ca. 5% of work.

Method development for new digestion methods has been an ongoing activity over the last two years. The sodium peroxide method has been successfully developed and current R&D is centred around transferring the HF mixed acid attacks to the new graphite hot plates. It is intended to develop these methods so that they can be put forward for UKAS accreditation in combination with ICP-AES finish.

Near future investments (planned/expected/required):

A replacement ICP-AES is scheduled for 2006

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 9 (Contest, Geopt and Quasimeme)

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	200	130	330
Income received per year (€):	11600	7300	18900

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 300

Theoretical max. utilisation: 2500[1], [2]

Man years on activity: 0.4[3]

Staff costs on activity (€): 13100

Expenses on service contracts in €/yr: 12300[2]

Direct costs of activity €/yr (excluding service contracts): 5100[2]

Additional Comments

[1] The theoretical maximum number of hours is limited by the size of the current autosampler, i.e. any run is limited to approximately 10 hours.

[2] The instrumentation is also used for the analysis of waters – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts and other direct costs are given as totals for the instrument. The split between waters and rocks is approximately 70:30 in terms of number of samples.

[3] No account has been of the number of samples or income from R&D activities and other lab based activities, such as training of visitors. However, the instrument utilisation and direct costs do cover these extra activities to a large extent. Maintenance of capability and other SB funding for this FY would amount to at least 25 SO days (equivalent to €5000 at basic rates) plus associated internal services.

Testscheme for activity 18: ***Inorganic analysis of dissolved solids by ICP-MS***

Instrumentation, including age, model and make:

VG ExCell ICP-MS instrument, with collision cell. Instrument delivery accepted in March 2000.

Brief description of method and applications (include comment on level of R&D vs. production):

(i) Determination of elemental concentrations in solids

Analysis of wide range of solids, e.g. rocks, soils, sediments, industrial materials such as gypsum and cement, air filters, pottery, vegetation, human and animal tissue, food stuffs, coal, bio-carbonates, etc. for total elemental content. Capable of performing detailed analysis on 0.1 g of sample. Method of digestion depends on sample matrix and target analytes. Methods include: (i) HF mixed acid attack (ii) sodium peroxide fusion; (iii) nitric acid digest in sealed microwave system.

Measurement methodology involves addition of internal standard via a t-piece and calibration against certified aqueous standards, which may be matrix-matched depending on the application. Determination of wide range of elements including heavy metals, REE, Th and U but can include major elements if application demands this.

Typical applications for total digestions include: REE, HFSE, U and Th to supplement XRFS data for major and trace elements for geochronology and rad waste research; heavy metals in gypsum and other materials from industrial processes; provenancing pottery for archeologists; analysis of air filters for air quality monitoring; heavy metals in marine sediments for CEFAS. Also samples from fluid-rock interaction experiments, leaching experiments (e.g. Wallingford SB work) and CISEDs but these are a relatively small proportion of the work – 5 to 10%.

(ii) Determination of U and Pb isotope ratios in sediments, soils and vegetation

Samples are digested, followed by chemical separation and preconcentration on ion-exchange columns prior to isotope ratio measurements by ICP-MS. We also undertake analysis for U isotopes subcontracted from other commercial laboratory serving the nuclear industry when they are overstretched.

(iii) R&D

1. A new and more rapid protocol for hot block digests suitable for UKAS accreditation; 2. Methods incorporating isotope dilution to improve accuracy and precision in a cost effective fashion developed as part of an MPhil degree for a member of the lab staff; 3. BGS-sponsored PhD students are investigating (i) dissemination of DU in the environment and (ii) development of biomarkers for arsenic and other heavy metals in contaminated land; 4. Training for visitors, e.g. Saudis.

Near future investments (planned/expected/required):

Purchase of HPLC to couple to ICP-MS instrument for research into arsenic speciation (and possibly other elements). Replacement autosampler has been put on list of minor capital items.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 2 GeoPT, 2 Quasimeme

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	1600	300	1900
Income received per year (€):	59500	17400	76900

Sample volume in % of total volume at laboratory: 3

Instrument utilisation (hours per year): 1200[1]   *Theoretical max. utilisation:* 3750[2], [3]

Man years on activity: 1.2[1]   *Staff costs on activity (€):* 68200

Expenses on service contracts in €/yr: 11000[2]

Direct costs of activity €/yr (excluding service contracts): 13100

Additional Comments

[1] No account has been taken of the number of samples or income from R&D activities and other lab based activities, such as training of visitors. However, the instrument utilisation and direct costs do cover these extra activities to a large extent. Maintenance of capability and other SB funding for this FY would amount to at least 10 SSO days, 25 HSO days, 40 SO days and 40 student days spread over water and digested solids by ICP-MS (equivalent to €23000 at basic rates) plus associated internal services where relevant.

[2] The instrumentation is also used for the analysis of waters – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts and direct costs are given as totals for the instrument. The combined amount for the analysis of waters and dissolved solids, including sample dissolution, separation and preconcentration (where applicable), cones, torches, standards, bottles, acids, etc., is €22000. The service contract for the PQ ExCell is €11000.

[3] Theoretical maximum utilisation is based on 15 hours, 5 days a week, for 50 weeks a year – this assumes that the utilisation is not limited by the availability of suitably qualified staff, which is not always the case. Also, no account has been taken of times when unattended operation is not possible, e.g. HLPC coupling, which requires continuous operator attendance. Instrument utilisation does not include any downtime or maintenance. Also, it should be noted that because of the large variety of materials analysed by ICP-MS, frequently it is not possible to analyse all sample types by the same methodology and time may be required between runs to clean and re-set the instrument. This is especially true for analysis such as isotope ratio measurements, GBASE waters and HPLC coupling, where achieving the instrument performance demanded by the customer requires time and skilled operators.

Test scheme for activity 19:	***Analysis of acid extracts: total digests and physiologically based weak leaches by ICP-AES***

Instrumentation, including age, model and make:

Inductively Coupled Plasma-Atomic Emission Spectrometry

Varian Vista Axial Pro, approximately 7 years old

Brief description of method and applications (include comment on level of R&D vs. production):

Determination of major and trace cations, typically Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sr, V and Zn in soils and other geological materials following digestion using mixed acid hot-block digestion or a weak leach such as PBET[1]. Other elements may be determined at the customer's request. The instrument is pre-calibrated using suitably matrix-matched multi-element standards covering the expected concentration ranges. Sample consumption is low, typically 3 ml, although sample volumes of less than 1.0 ml have been run successfully on this instrument. Digests of samples require a minimum five-fold dilution prior to analysis. Physiologically based extraction (PBET) leaches are run neat. Both methods include 1% CsCl as an ionisation suppressant.

The instrument has separate glassware (i.e. nebuliser, spray chamber and torch) configurations for the determination of cations in waters, and for digests and leaches of rocks and soils.

The level of R&D currently spent on the soils configuration is minimal versus production.

Near future investments (planned/expected/required):

Validation and accreditation of new methods (e.g. the soils method for UKAS and MCERTs accreditation), requiring mostly staff time and consumables and possibly expenditure on glassware.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 4

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	900	100	1000
Income received per year (€):	111000	12300	123300

Sample volume in % of total volume at laboratory: 4

Instrument utilisation (hours per year):	500[3]	*Theoretical max. utilisation:*	3000[2]
Man years on activity:	1.25[3]	*Staff costs on activity (€):*	58000
Expenses on service contracts in €/yr:			9700[2]
Direct costs of activity €/yr (excluding service contracts):			22800

Additional Comments

[1] This activity can be split into categories (a) total digestion, including CISED, (b) leachable and (c) weak leaches. Approximately 95% of this activity comprises analysis of total acid extracts and PBET extracts for bioaccessibility. This activity also incorporates the analysis of solutions derived during Chemometric Identification of Substrates and Element Distributions (CISED); representing <5% of the analytical throughput. Leachable analysis is carried out only occasionally.

[2] The instrumentation is also used for the analysis of waters – refer to the relevant testscheme for activity. Values for theoretical maximum utilisation and expenses on service contracts are given as totals for the instrument.

[3] Although the instrument time appears low in comparison to staff costs and man years, the latter two items include preparation and digestion of samples prior to analysis.

Testscheme for activity 20: ***Total carbon and total organic carbon in sediments***

Instrumentation, including age, model and make:

Total carbon Analyser, 2 years old, Elementar, CN VarioMax

Brief description of method and applications (include comment on level of R&D vs. production):

Non-volatile total carbon (TC) and total organic carbon (TOC) in solid geological materials (e.g. soil, rock, sediment, coal, etc.) are determined by combustion to carbon dioxide, which is measured using a thermal conductivity detector (TCD). Determination of TOC is performed by removal of carbonate (TIC) by acidification prior to analysis. Total inorganic carbon (TIC) is calculation by difference, TC-TOC=TIC.

TC, TOC and TIC data are essential parameters in establishing basic soil / sediment chemical characteristics.

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes: Currently in preparation for accreditation

Participation in proficiency testing – number of tests per year for activity: 22

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	2	475	477
Income received per year (€):	800	10200	11000

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 200 *Theoretical max. utilisation:* 4000

Man years on activity: 0.15 *Staff costs on activity (€):* 7800

Expenses on service contracts in €/yr: 3200

Direct costs of activity €/yr (excluding service contracts): 3000

Testscheme for activity 21: ***XRFS sample preparation***

Instrumentation, including age, model and make:

Fritsch P1 laboratory jaw crusher: 10 yrs

GenLab. Fan assisted drying oven: 3yrs

Siebtechnik vibrating-cup (tema) mill with 2 x 150ml capacity agate milling vessels: 15 yrs

Retsch PM400 ball mill with 24 agate milling vessels: 2 yrs

Herzog HTP 40 semi-automatic pellet press (calibrated and maintained by accredited external laboratory): 15 yrs

Brief description of method and applications (include comment on level of R&D vs. production):

The method is designed to provide up to 70 finely milled powders and/or pressed powder pellets per day with minimal addition of contaminants from preparation equipment. The comminution processes used reduce the entire sample to a homogenous powder (< 250 microns maximum particle size) to allow sub-sampling for fine milling (to < 40 microns).

Finely milled powders are presented directly for major element determinations and powders intended for trace element determinations are milled with a wax binder prior to pressing in to 40 mm diameter pellets by pressing to 25kN in a pellet press. The costs for this are included in this testscheme, but are also duplicated in the XRFS testcheme for easy comparison with GTK and NGU.

The method is applied to rocks (500 to 800 samples per year) soils (4000 to 10000 per year) sediments (2000 to 4000 per year) panned concentrates (400 to 800 samples per year).

Approximately 5% of samples processed per annum are for R&D purposes

Near future investments (planned/expected/required):

A new laboratory designed to process environmental materials including contaminated soils and sediments is currently being commissioned and will increase the variety of materials that can be prepared and analysed

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No (please see comment below)

Comment if yes:

Sample preparation procedures are quality controlled and externally audited in support of accredited analytical methods.

Participation in proficiency testing – number of tests per year for activity: 50

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	1000	10000	11000
Income received per year (€):	11200	109000	120200

Sample volume in % of total volume at laboratory: 8

Instrument utilisation (hours per year): 2600 *Theoretical max. utilisation:* 3200

Man years on activity: 4 *Staff costs on activity (€):* 129000

Expenses on service contracts in €/yr: 450

Direct costs of activity €/yr (excluding service contracts): 11000

Testscheme for activity 22: *X-ray Fluorescence Analysis*

Instrumentation, including age, model and make:

Wavelength Dispersive X-Ray Fluorescence Spectrometry (WD-XRFS)

Philips PW2400, 14 years old; Philips MagiX-PRO (PW2440), 4 years old and

PANalytical Axios advanced (PW4400), <1 year old

Energy Dispersive X-Ray Fluorescence Spectrometry (ED-(P)XRFS)

PANalytical Epsilon5, 2 years old; PANalytical Epsilon5, <1 year old and

Niton Xlt700 handheld 1 year old

Brief description of method and applications (include comment on level of R&D vs. production):

WD-XRFS fused bead analysis for the determination of:
SiO_2, TiO_2, Al_2O_3, Fe_2O_3t, Mn_3O_4, MgO, CaO, Na_2O, K_2O, P_2O_5, SO_3, Cr_2O_3, NiO, CuO, ZnO, SrO, BaO, ZrO_2 and PbO and including LOI at 1050°C

WD-XRFS pressed powder analysis for the determination of:
Sc, V, Cr, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Y, Zr, Nb, Mo, Ag, Cd, Sn, Sb, Te, I, Cs, Ba, La, Ce, Nd, Sm, Yb, Hf, Ta, W, Tl, Pb, Bi, Th and U

ED-(P)XRFS pressed powder analysis for the determination of:
Ag, Cd, In, Sn, Sb, Te, I, Cs, Ba, La and Ce
Auto quantification of all detectable elements present in liquids, solids and powders

Handheld ED-XRFS
In situ soils and minerals, elements from Ca- U

Near future investments (planned/expected/required): Bench top ED-XRF required for mobile analysis

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: Yes

Comment if yes:

Fused bead analysis by WD-XRFS: UKAS accreditation

Loss on Ignition (for incorporation with fused beads): UKAS accreditation

Pressed Powder Pellet analysis by WD-XRFS: UKAS accreditation and MCERTS for V, Cr, C, Ni, Cu, Zn, As, Se, Mo, Tl and Pb

Pressed Powder Pellet analysis by ED-XRFS: UKAS accreditation and MCERTS for Cd, Sb and Ba

Participation in proficiency testing – number of tests per year for activity: 18

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	1000	10000	11000
Income received per year (€):	48000	333500	381500

Sample volume in % of total volume at laboratory: 16.5

Instrument utilisation (hours per year): 5275 *Theoretical max. utilisation:* 7536

Man years on activity: 5.8 *Staff costs on activity (€):* 229000

Expenses on service contracts in €/yr: 50800

Direct costs of activity €/yr (excluding service contracts): 29000

Additional Comments

[1] The figures for XRFS analysis include preparation of pressed powder pellets and/or fused glass beads, but not other sample preparation (crushing, milling, etc).

Testscheme for activity 23: ***XRD sample preparation***

Instrumentation, including age, model and make:

Fritsch P1 jaw crusher: 10 yrs

GenLab fan assisted drying oven: 3yrs

Siebtechnik vibrating-cup (tema) mill with stainless steel milling vessels (4) and agate milling vessels (2): 15 yrs

Brief description of method and applications (include comment on level of R&D vs. production):

Samples are reduced in particle size by crushing and short cycle tema milling and screening at a requested mesh size (normally 100 µm to 200µm) to minimise strain in the crystal lattice.

The method is applied to rocks, sediments, panned concentrates and soils

Not all samples received for XRD analysis require preparation, hence the number of samples quoted here is significantly less than that in the relevant analysis testscheme. The data presented here predominantly represent course crushing and milling.

Near future investments (planned/expected/required):

A new laboratory designed to process environmental materials including contaminated soil and sediment samples is currently being commissioned and will increase the range of materials that can be prepared for this technique. Demand for this service is expected to increase steadily (5 to 10% per year for next two or three years).

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: NO

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	150	150	300
Income received per year (€):	1500	1500	3000

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 80 *Theoretical max. utilisation:* N/a

Man years on activity: 0.1 *Staff costs on activity (€):* 2900

Expenses on service contracts in €/yr: nil

Direct costs of activity €/yr (excluding service contracts): 580

Test scheme for activity 24: *X-ray diffraction (XRD)*

Instrumentation, including age, model and make:

PANalytical X'Pert Pro diffractometer, Philips PW1700 – series diffractometer

PANalytical X'Pert software suite including X'Pert HighScore Plus Rietveld quantification

ICDD (2004) phase identification database, ICSD (2005) crystal structure database

Brief description of method and applications (include comment on level of R&D vs. production):

X-Ray Diffraction (XRD) is probably the most important analytical technique for identifying and quantifying the mineral constituents of geological materials and clay minerals in particular. XRD may also provide information about the crystallinity and chemistry of the component minerals. BGS has over 35 years experience of applying XRD techniques to geological materials and sedimentary rocks in particular. Two types of analyses are typically provided: firstly, powder analysis to determine and quantify the whole-rock mineralogy; and secondly, <2 µm oriented mount analysis to determine the nature and quantify any clay minerals present.

XRD is employed on projects spanning the BGS programme. In the recent past XRD proved to be one of the cornerstones of the large characterisation and R&D projects for radioactive waste disposal. It has also provided essential data to strategic, multidisciplinary UK and International geological mapping projects. Industrial and environmental mineralogy, engineering geology, hydrocarbon and CO_2 sequestration research have also benefited from the interpretive science based on XRD. The laboratory has also over time built-up a large portfolio of commercial clients, providing direct commercial analyses particularly for the mineral, environmental and engineering industries. In the future, XRD will play a major role in the characterisation of soils and Quaternary deposits, a major component of BGS's 2005-10 SB programme.

The laboratory principally carries out interpretative, applied research costed as project staff time with a small component of R&D. The Section is staffed by small team of specialist staff, presently at SSO and SO grades but also accommodates BGS non-specialist users and supervises the work of Overseas trainees and domestic PhD/MSc students.

Equipment has recently been upgraded to state-of-the-art level, while older equipment has proved generally reliable and relatively cheap to maintain. Excellent working relationships with equipment manufacturers have resulted in major upgrades being negotiated in return for appraisal and R&D.

Near future investments (planned/expected/required):

Planned low temperature/humidity stage in next 2 years

Expected annual software/database upgrades

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): A/C

Is the activity wholly or partly accredited?: No

Comment if yes: n/a

Participation in proficiency testing – number of tests per year for activity: none

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	900	500	1400
Income received per year (€):	72500	33400	105900

Sample volume in % of total volume at laboratory: 5

Instrument utilisation (hours per year): 4000

Theoretical max. utilisation: 8760

Man years on activity: 1.8

Staff costs on activity (€): 101500

Expenses on service contracts in €/yr: 4400

Direct costs of activity €/yr (excluding service contracts): 7300

Testscheme for activity 25: ***Scanning Electron Microscope (SEM) Analysis***

Instrumentation, including age, model and make:

LEO 435VP SEM (variable pressure instrument), with: Oxford instruments ISIS300 EDS system, Oxford instruments cryogenic preparation and transfer unit (CT1500), Oxford instruments MiniCL and MonoCL detector/spectrometers, scanning transmission electron detector, KE developments backscattered electron detector, and Kontron KS400 on-line image analysis system. Purchased new in 1996.

Cambridge-Leica S360 SEM, with Oxford instruments INCA EDS system, Oxford instruments winspec WDS detector, Oxford instruments cryogenic preparation and transfer unit (CT1500) and Oxford instruments MiniCL detector. Instrument built early 1990s(?) and moved to BGS from the British Antarctic Survey in 2003.

Fully equipped preparation lab-facility (shared with electron microprobe facility), comprising: Edwards 306A evaporation coater (1980), Emitech evaporation and sputter coater (1996), Edwards Modulo freeze drier (unknown age), and Balzer critical point drier (unknown age).

Brief description of method and applications (include comment on level of R&D vs. production):

The SEM “method” provides high resolution topographic and/or compositional images. The SEM can also be used for point-analyses where characteristic X-ray or optical spectra from analytical points can be measured enabling elemental analysis. Analysis is typically investigative in nature - this means that each job undertaken is likely to be different to any other job. This is in marked contrast to a number of other analyses where each sample is analysed in the same way to generate result(s).

The SEMs are used in the analysis of a wide range of materials including: rocks, minerals, soils and dusts. Our equipment is principally used for high resolution petrographical analysis including investigation of rock fabrics, mineral intergrowths, identification of mineral zoning fabrics, characterisation of fracture surfaces, mineral identification and mineral compositional analysis. This work is in support of a wide range of projects related to diagenesis, mineralisation, characterisation of fractured rocks, environmental mineralogy, hydrocarbon reservoir characterisation and aquifer characterisation. The instruments are also used in the characterisation of reaction products from hydrothermal experiments, in support of systematic survey activities, and also in the characterisation of micro-fossils.

The cryogenic and variable-pressure capability of the LEO435VP instrument is used for the analysis of vacuum, temperature and beam sensitive materials (such as gas hydrates) which are not possible using convention SEM techniques.

The workload is a fairly even balance between commissioned research projects and science budget projects. The SEM facility has strong links with the BGS’s EPMA and optical microscopy facilities.

Near future investments (planned/expected/required):

One instrument is planned to be replaced within the next 4 years. Discussions are beginning about whether this upgrade should focus on improving our microchemical analytical capability or improving our environmental SEM capability (or some trade-off between the two).

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A **note 1**

Is the activity wholly or partly accredited?: No

Comment if yes: The analysis is typically investigative in nature – an activity which does not readily lend itself to accreditation.

Participation in proficiency testing – number of tests per year for activity: None

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	150 **note 2**	150 **note 2**	300
Income received per year (€):	72500 **note 3**	72500 **note 3**	145000

Sample volume in % of total volume at laboratory: 5

Instrument utilisation (hours per year): 700-1000 **note 4**

Theoretical max. utilisation: 3000 **note 5**

Man years on activity: 1.6 **note 6**

Staff costs on activity (€): 95800 **Note 6**

Expenses on service contracts in €/yr: 50800

Direct costs of activity €/yr (excluding service contracts): 2200 **Note 7**

Testscheme for activity 26: *Electron Microprobe Analysis (EPMA)*

Instrumentation, including age, model and make:	Cameca SX-50 (3 WDS and 1x PGT EDS spectrometer): Installed 1989. Cambridge Instruments Microscan 5 (including 1x Link An10000 EDS spectrometer): c. 33 years old, purchased second hand and installed at BGS in 1986. Fully equipped preparation lab-facility, shared with scanning electron microscope facility.

Brief description of method and applications (include comment on level of R&D vs. production):

Additional Comments

Note 1: It is anticipated that at some point within the next few years, due to a proposed purchase of a new electron microscope a degree of rationalisation of our electron microbeam facilities will occur, and that some work currently carried out by EPMA will shift to SEM-based methods.

Note 2: Approximate number of samples tested per annum does not give a true picture of the laboratories throughput. The work ranges from rapid analysis where 10-20 samples might be investigated within 1 day, to detailed studies where up to a week might be used to analyse each sample.

Note 3 Direct income for actual SEM analyses is probably of the order of €145000, but the SEM results are rarely supplied as a product in their own right, and significant additional income is also derived from the interpretation and integration of the results with larger-scale project objectives. Furthermore, the availability of this facility in-house enables BGS to undertake certain projects that would not otherwise be possible, and the SEM facility underpins commissioned and science budget projects worth of the order of €435000 per annum.

Note 4: Instrument utilisation figure are based the period 01-01-2003 to now. This has been a relatively quiet period in the history of the facility. This is largely due to levels of analytical work dropping off during the closing stages of the last BGS science programme (which ended in March 2005) and a relatively slow start to the new programme (which commenced April 2005). Utilisation levels are currently increasing as the new programme gathers momentum.

Note 5: This figure is based on the fact that both instruments are generally used for attended operation only. However, the LEO435VP does have the capability for automated image acquisition and microchemical analysis, although this is only rarely used at present.
200 working days per year * 7.4 hours * 2 instruments = 2960 hours.

Note 6: The value quoted here is the time spent by the user actually at the instrument, plus time spent directly processing data, interpreting data and incorporating data/interpretations into the larger scale projects. It also includes time spent on instrument maintenance and associated activities.
Analysis and interpretation: c. 300 days at a mixture of SO, HSO, SSO and PSO grades (average SSO):
= 300 * 7.4 = 2220 hours
Approx staff cost c. €87000
Maintanence / servicing (exclusively SO grade)
= 30 days * 7.4 = 222 hours.
Approx. staff cost c. €5800
TOTAL = 2442 hours per annum ~ 1.6 man years.

Note 7: Direct costs include minor general laboratory consumables, liquid nitrogen and compressed gases.

EPMA provides quantitative chemical analysis of small grains or micro-areas of samples down to 1 µm in size, microchemical maps of samples on a scale of a few microns to a few cms, rare phase searching for small particles.

The SX-50 is used for a range of activities including: support to systematic surveys, mineral exploration, investigations of trace element zoning within fracture-filling minerals. The Microscan is almost exclusively used for compositional analysis of heavy minerals on commissioned research projects.

The workload is, on average, fairly evenly split between commissioned research and science budget projects, although in recent years a large overseas mapping project has slightly skewed this balance in favour of commissioned research.

The EPMA facility has strong links with the BGS's SEM and optical microscopy facilities.

Near future investments (planned/expected/required):

It is recognised that the Microscan is approaching the end of its useful life. Alternative SEM-based techniques are currently being evaluated/devised with a view to decommissioning this instrument within the next few years.

The SX-50 is also due for renewal (being over 15 years old) – however utilisation levels and the flexibility offered by the instrument make significant investment difficult to justify at the present time. See **note 1**.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): B **note 2**

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: Occasional **Note 3**

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	40-60 **note 4**	40-60 **note 4**	80-120
Income received per year (€):	36300 **Note 5**	36300 **Note 5**	72600

Sample volume in % of total volume at laboratory: 3

Instrument utilisation (hours per year): 2250 **note 6**

Theoretical max. utilisation: 8680 **note 7**

Man years on activity: 1.0 **note 8**

Staff costs on activity (€): 40000 **Note 8**

Expenses on service contracts in €/yr: 18000

Direct costs of activity €/yr (excluding service contracts): 2200 **Note 9**

Additional Comments

Note 1: In order to justify expenditure on a replacement dedicated EPMA instrument, BGS needs to seriously consider the levels of support and marketing required to make any investment cost–effective.

Note 2: It is anticipated that at some point within the next few years a degree of rationalisation of our electron microbeam facilities will occur related to the proposed purchase of a new electron microscope. It is envisioned that much of the work currently carried out using the Microscan 5 will shift to SEM-based methods. The SEM-based methods, however, do not currently offer the speed of analysis for minor element microchemical mapping, and trace-element analysis currently available using the SX-50.

Note 3: The facility participates in occasional interlaboratory sample-exchange schemes, which run every few years. Our performance routinely compares very favourably with that of other similar facilities.

Note 4: Approximate number of samples tested per annum cannot really be meaningfully applied to the range of work carried out. The work ranges from single point analyses of samples where 10-20 analyses might be made in a couple of hours to detailed studies where 1-2 weeks of instrument time might be required to analyse each sample

Note 5: Direct income for actual probe analyses is probably of the order of €72500 (based on utilisation of 150 days of time at SO grade and 10 days at SSO grade). However, the probe data is rarely supplied as the product in itself and significant additional income is also derived from the interpretation and integration of the results with larger-scale project objectives. Furthermore, the availability of this facility in-house enables BGS to undertake certain projects that would not otherwise be possible.

Note 6: This figure is based on
SX-50 – instrument used c. 120 days per year– involving overnight/weekend runs in c. 50% of cases
= (60 days * 7.4 hours) + (60 days * 24 hours) = 1884 hours
Microscan – c. 50 days attended operation
= 45 days * 7.4 hours = 370 hours
TOTAL = 2254 hours per annum.

Note 7: This figure is based on:
SX-50 – this instrument has the potential to be run 24 hours a day, seven days a week:
= 300 days * 24 hours = 7200 hours.
Microscan – this instrument can only be used for attended analysis
= 200 days * 7.4 hours = 1480 hours
TOTAL = 8680 hours per annum.

Note 8: The SX-50 is routinely set-up for unattended analysis - i.e. the user spends a couple of hours setting up an analytical run, which may then run unattended for a period of several hours or even days, before coming back and spending an hour or two extracting the results. The value quoted here is the time spent by the user actually at the instrument, plus time spent directly processing data, interpreting data and incorporating data/interpretations into the larger scale projects. It also includes time spent on instrument maintenance and associated activities.
SX-50 – c. 120 days (predominantly SO grade)
= 120 days * 7.4 = 888 hours.
Approx staff cost c. €23200
Microscan – c. 50 days (almost exclusively SO grade)
= 50 days * 7.4 = 370 hours.
Approx staff cost c. €11000
Maintanence / servicing (exclusively SO grade)
= 30 days * 7.4 = 222 hours.
Approx. staff cost c. €5800
TOTAL = 1480 hours per annum ~ 1.0 man years.

Note 9: Direct costs include minor general laboratory consumables, liquid nitrogen and compressed gases.

Testscheme for activity 27: *Laser ablation ICP-MS*

Instrumentation, including age, model and make:

Custom Laser Ablation MicroProbe (266nm Nd:YAG laser integrated with Leitz microscope) coupled to a VG PlamaQuad 2+ ICP-MS instrument with S-option. Age of equipment 14 years.

Brief description of method and applications (include comment on level of R&D vs. production):

The Laser Ablation MicroProbe (LAMP) is a means of taking microscopic (5-100 microns) solid samples of environmental, geological or industrial materials, directly from thin sections, polished blocks or even rough cuts and analysing the resulting ablated material on-line by ICP-MS for a variety of major, minor and trace elements. Detection limits down to sub-ppm concentrations may be obtained.

Typical recent applications include: (i) the composition of fracture minerals, for a variety of natural analogue elements, in nuclear waste disposal site characterisation; (ii) location, concentration and isotopic composition of depleted uranium in soils; (iii) natural environmental marker and contaminant elements in biogenic carbonates (shells, corals and otoliths); (iv) source region marker elements in heavy minerals for sedimentary geochemistry studies by the oil industry; (v) industrial samples to solve production quality problems.

All of these are contract research with a significant R&D component, the LAMP-ICP-MS technique being capable of solving problems where other techniques have failed.

Near future investments (planned/expected/required):

The equipment is reaching the end of its useful life. Although its performance has been maintained, more modern instrumentation would significantly surpass it in many aspects and reliability is an increasing problem, as will be obtaining spares in the event of catastrophic failure.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on today's level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: None currently available

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	3200	200	3400[1]
Income received per year (€):	29000	1500	30500[2]

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 250

Theoretical max. utilisation: 1850[3]

Man years on activity: 0.2[4]

Staff costs on activity (€): 11600

Expenses on service contracts in €/yr: 10600

Direct costs of activity €/yr (excluding service contracts): 5800

Additional Comments

[1] The number of samples quoted is the number of ablation data points; any one test material may have between 1-200 ablation points performed on it. This equates to approximately 50-70 bulk samples.

[2] Income includes staff time integral to the interpretation of the analytical data but not project management.

[3] The theoretical maximum utilisation is based on 7.4 hours, 5 days a week, for 250 days a year. No downtime or maintenance is included and it assumes that an infinite amount of suitably qualified staff available.

[4] Costs and staff effort does not include a heavy maintenance requirement to keep this ageing equipment in a suitable condition for the analysis. The equipment is particularly susceptible to problems resulting from power outage (and floods). The overhead on staff effort for maintenance is probably running at approximately 20%.

The above figures also do not include the ca. 40 workings days when a gas chromatograph (GC) was coupled to the PQ2+ instrument, rather than the LAMP. This was a development project aimed at determining mercury and tin organo-metallic species. This collaborative study with a local university resulted in several conference presentations and publications.

Testscheme for activity 28: **Thin Sectioning Service**

Instrumentation, including age, model and make:

Main Laboratory:-2 Bulk rock Saws; 2 precision rock saws; 3 precision lapping machines with accessory plate control equipment; 2 sample lapping machines; 1 Cut-off and grinding machine:1 Precision surface grinder: 2 diamond hand grinding machines; 2 hotplates; 3 hand lapping stations; 5 microscopes. 3 fume cupboards; various gauging and conditioning accessories.

Polishing Laboratory:- 5 multi-sample polishing machines; 3 single sample polishing machine; basic reflected light microscope.

Brief description of method and applications (include comment on level of R&D vs. production):

Production of thin sections, from a wide range of geological and material derived from anthropogenic activities. The latter includes bricks, concrete, and archaeological materials.

Different types of thin section are made to match the research needs of our customers who comprise BGS staff, universities, oil companies and independent consultants worldwide. The basic types of thin sections produced include:

1. Standard cover-slipped sections and coloured resin vacuum impregnated sections, which are used in transmitted light microscopy.
2. Polished thin sections and blocks, which are used in analytical equipment that utilize high-energy electromagnetic radiation to ‘probe’ the sample (e.g. SEM; laser ablation).
3. Fluid inclusion wafers. Used for thermometric investigation of minute liquid/gas inclusions in natural crystals.
4. Polished grain sections, for dating and zoning of (say), zircon grains.

Near future investments (planned/expected/required): On-going replacement of failed or ageing equipment.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: NONE

	External contracts	*Internal contracts*	*Total*
Number of sections made per year: (APPROX)	1000	3000	4000
Income received per year (€):(APPROX)	21800	65300	87100

Sample volume in % of total volume at laboratory: 6

Instrument utilisation (hours per year): 3900 *Theoretical max. utilisation:* 4800

Man years on activity: 3 *Staff costs on activity (€):* 145000

Expenses on service contracts in €/yr: NONE

Direct costs of activity €/yr (excluding service contracts): 17400

Testscheme for activity 29: *Grain size determination*

Instrumentation, including age, model and make:

GenLab fan assisted drying oven: 3yrs

AS200 wet or dry sieve station: 1yr

Brief description of method and applications (include comment on level of R&D vs. production):

Particle size distribution analysis from 63mm to 50 microns on a wet or dry basis. Samples are weighed, sieved and the data presented according to customer requirements. Generally samples are processed according to British Standard (BS) or BS European Norm (BSEN) methods.

Approximately 10% of the samples processed are for R&D purposes

Near future investments (planned/expected/required):

Recent investment in PSD equipment means that no further investments are planned in the short/medium term.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: NO

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	100	100	200
Income received per year (€):	2200	2200	4400

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 100

Theoretical max. utilisation: 800

Man years on activity: 0.1

Staff costs on activity (€): 3000

Expenses on service contracts in €/yr: nil

Direct costs of activity €/yr (excluding service contracts): 400

Testscheme for activity 30: *Grain Size Distribution*

Instrumentation, including age, model and make:

Micromeritics Sedigraph Model 5100 Particle Size Analyser, 1993 including Micromeritics Mastertech 51 Automatic sample preparation/feeding carousel.

Used for fine grained analysis, following sieving of coarse fraction.

[British Standard BS 1377:1990 Hydrometer and Pipette methods are also used to supplement Sedigraph fine grain size analyses as required]

Brief description of method and applications (include comment on level of R&D vs. production):

Used for fine-grained (silt/clay) analysis following sieving of coarse fraction above 3 mm (fine/medium sand size).

Fine-grained analysis using Sedigraph is by X-ray absorption on particles held in suspension of weak disaggregating solution.

Automated analyses produces numeric, statistical and graphical output of grain size distribution data.

Used on a spectrum of BGS- wide projects requiring grain size distribution data of superficial deposits, soils and weathered rock materials. Analyses are primarily undertaken to underpin R&D projects. Approximate 70% R&D applications vs. 30% commissioned/commercial production.

Near future investments (planned/expected/required):

€50 000 investment in new Sedigraph and automated sample carousel – needed 2006.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: N/A

Comment if yes: Sieving and sample prep done in accordance with British Standard BS 1377. 1990. Sedigraph technique is not yet part of British Standard methods of test but is allowable as it conforms to the principles of Stoke's Law, on which BS standard hydrometer and pipette analyses are based.

Participation in proficiency testing – number of tests per year for activity: N/A

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	150	350	500
Income received per year (€):	8700	9400	18100

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 500 *Theoretical max. utilisation:* 1800

Man years on activity: 0.3 *Staff costs on activity (€):* 13200

Expenses on service contracts in €/yr: 3600

Direct costs of activity €/yr (excluding service contracts): 150

Additional Comments

[1] The BGS particle size testing facility (Geotechnical Laboratories) does not have dedicated laboratory technicians to undertake grain size distribution tests. Due to limited time allocations available for scientific staff to undertake such work, the grain size distribution testing facility does not set out to win large orders from commercial clients simply to produce standard grain size distribution data as a 'handle-turning' exercise to make money. Lab scientists undertake the tests primarily to underpin 'Internal' SB research or as an integral requirement of 'External' commissioned research projects. Currently, relatively few jobs are taken on simply to provide grain size distribution data for commercial clients.

[2] The acquisition of grain size distribution data in BGS is expected to increase from 2006 in line with the strategic requirement for property attribution of the 3D geological models.

Testscheme for activity 31: *Mineral Separation*

Instrumentation, including age, model and make:

Fitsch P1 Laboratory jaw crusher: 10yrs

Vibrating cup (Tema) mill: 15yrs

Soni-prep ultrasonic probe: 6yrs

Brief description of method and applications (include comment on level of R&D vs. production):

The method is applied mainly to powdered rocks sediments and soils. The sample is prepared for separation by removing fine particles adhering to the tailings using an ultra-sonic probe and the cleaned particles are then separated according to their densities by passing them through a heavy liquid solvent (normally bromoform or methylene iodide) if required the specific gravity of the solvent is adjusted by dilution with acetone allowing the separation of specific mineral fractions.

Approximately 90% of the samples processed are for R&D purposes.

Near future investments (planned/expected/required):

Minor investment is planned in the near future to allow commissioning of a new method employing a less hazardous media for separating target minerals.

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: NO

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: NO

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	50	80	130
Income received per year (€):	2500	4100	6600

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 60 *Theoretical max. utilisation:* 400

Man years on activity: 0.1 *Staff costs on activity (€):* 3000

Expenses on service contracts in €/yr: Nil

Direct costs of activity €/yr (excluding service contracts): 900

Testscheme for activity 32: Determination of pH in soils by $CaCl_2$ slurry method

Instrumentation, including age, model and make:

Orion 720 Meter 15 years

Brief description of method and applications (include comment on level of R&D vs. production):

A portion of sample is mixed with $CaCl_2$ solution to give a final solid to solution ratio of 1:2.5. Soil pH is measured potentiometrically by immersing a solid body combined pH electrode into a suspension of the soil to be analysed

Near future investments (planned/expected/required):

New meter with ability to talk directly to LIMS system

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): B

Is the activity wholly or partly accredited?: Yes

Comment if yes: The method is accredited for both UKAS and MCERTS

Participation in proficiency testing – number of tests per year for activity: 8

	External contracts	Internal contracts	Total
Number of samples analysed per year:	3126	1036	4162
Income received per year (€):	19300	6000	25300

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 550

Theoretical max. utilisation: 1400

Man years on activity: 0.4

Staff costs on activity (€): 13800

Expenses on service contracts in €/yr: 40

Direct costs of activity €/yr (excluding service contracts): 300

Testscheme for activity 33: **_Determination of LoI @ 450°C_**

Instrumentation, including age, model and make:

Scientific supplies BS3 Oven 20 years

Carbolite RHF 12/13 furnace – 10 years

Elite BCRF 12/13 furnace 1yr

Brief description of method and applications (include comment on level of R&D vs. production):

Samples are initially dried at 105°C to remove any residual moisture and are then placed in a furnace at 450°C for 4 hours. The weight loss between the sample weight after it has been dried at 105°C and that after it has been heated at 450°C is calculated as a proportion of the initial sample weight (after drying at105°C) and expressed as a percentage.

Near future investments (planned/expected/required): None

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): B

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 8

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	3134	1036	4170
Income received per year (€):	25000	7800	32800

Sample volume in % of total volume at laboratory: 1

Instrument utilisation (hours per year): 500 *Theoretical max. utilisation:* 1600

Man years on activity: 0.3 *Staff costs on activity (€):* 10900

Expenses on service contracts in €/yr: 100

Direct costs of activity €/yr (excluding service contracts): 200

Testscheme for activity 34: *PAHs in soils and waters using HPLC*

Instrumentation, including age, model and make:

HPLC system, 17 years old, Waters 600E

Fluorescence Detector, 4 years old, Waters 474

Brief description of method and applications (include comment on level of R&D vs. production):

Polycyclic Aromatic Hydrocarbons (PAH) are members of organic compounds widely distributed in the atmosphere and lung cancer has been linked to PAH exposure through inhalation. The largest anthropogenic sources of PAHs are from vehicular emissions, coal and oil combustion, waste incineration and petroleum refining.

PAHs are extracted from sediment / soil samples using a suitable solvent with ultrasonication and from waters using solid phase extraction (SPE). The PAHs in the extract are determined using high pressure liquid chromatography (HPLC) with fluorescence detection. Certified reference materials (sediment) are used for quality control.

Data mainly used for R&D purposes rather than 'production'.

Near future investments (planned/expected/required): None anticipated

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: 8

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	-	100	100
Income received per year (€):	-	1100	1100

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 350 *Theoretical max. utilisation:* 1610

Man years on activity: 0.2 *Staff costs on activity (€):* 1100

Expenses on service contracts in €/yr: 1500

Direct costs of activity €/yr (excluding service contracts): 800

Testscheme for activity 35: ***PCBs in sediments by GCMS***

Instrumentation, including age, model and make:

GCMS, 12 years old, Fisons, MD800

Accelerated Solvent Extraction (ASE), 2 years old, Dionex, ASE 200

Brief description of method and applications (include comment on level of R&D vs. production):

Polychlorinated biphenyls (PCBs) are man-made organic compounds which over year of production and use have contaminated sediment and soils. They are endocrine disruptors and bio-accumulate in animal tissues.

A dry sediment sample (10g) is spiked with various internal standards and the PCBs extracted using an accelerated solvent extraction (ASE). After a rigorous sample clean-up procedure of the extract, the PCBs are determined using gas-chromatography mass spectrometry (GCMS). Certified reference materials (sediment) are used for quality control.

Data mainly used for R&D purposes rather than 'production'.

Near future investments (planned/expected/required):

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: none

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	-	50	50
Income received per year (€):	-	23200	23200

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 200 *Theoretical max. utilisation:* 6000

Man years on activity: 0.18 *Staff costs on activity (€):* 9500

Expenses on service contracts in €/yr: 2400

Direct costs of activity €/yr (excluding service contracts): 900

Testscheme for activity 36: ***Total Petroleum Hydrocarbons in sediments and soils***

Instrumentation, including age, model and make:

Thin layer chromatography - flame ionisation detector (TLC-FID), 2 years old, Iatroscan, Mk-6

Accelerated Solvent Extraction (ASE), 2 years old, Dionex, ASE 200

Brief description of method and applications (include comment on level of R&D vs. production):

The Iatroscan equipment is a thin layer chromatography - flame ionisation detector (TLC-FID) technique that separates and quantifies broad classes of non-volatile organic compounds according to their polarity (aromatic, aliphatic, and polar / NSO). The sum of aromatics + aliphatic = total petroleum hydrocarbons (TPH). It can be used as a rapid screening method for soils pollutants, petroleum hydrocarbons, source rocks, etc.

Solvent extractable organic matter is extracted from sediment using 'accelerated solvent extraction' (ASE). The resulting solvent extract is evaporated to 'dryness' using a stream of nitrogen and made-up to a known volume using toluene. A known volume of this organic extract is deposited on silica-coated quartz rods called 'Chromrods' by a process known as 'spotting'. The rods are then 'developed' in a series of 2 suitable solvents contained in a shallow tank with the 'sample spot' above the solvent level. The solvent moves up the silica coating, by capillary action. The broad classes of organics (aromatics and aliphatics) are separated according to their interaction with the stationary phase (the silica) and the mobile phase (the solvent), this process is known as 'developing the rods'. The developed rods are then placed into the pre-calibrated Iatroscan instrument.

A flame ionization detector (FID) moves along the rods, as the organics are 'burned-off' the FID measures the conductivity of the flame, this is registered as an increase in voltage (called the response). The response is directly proportional to the amount of organic material in the rod (i.e. quantitative results).

Data mainly used for R&D purposes rather than 'production'.

Near future investments (planned/expected/required): None anticipated

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): A

Is the activity wholly or partly accredited?: No

Comment if yes:

Participation in proficiency testing – number of tests per year for activity: none

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	-	99	99
Income received per year (€):	-	4100	4100

Sample volume in % of total volume at laboratory: <0.5

Instrument utilisation (hours per year): 200 *Theoretical max. utilisation:* 1610

Man years on activity: 0.06 *Staff costs on activity (€):* 3100

Expenses on service contracts in €/yr: 1200

Direct costs of activity €/yr (excluding service contracts): 800

Testscheme for activity 37: *Gamma ray spectrometry*

Instrumentation, including age, model and make:

Canberra Harwell system

37 % and 17.4 % relative efficiency HpGe detectors, NIM Acquisition Interface Module, HV power supplies, Spectroscopy amplifiers, ADCs, Genie 2000 multi-input basic spectroscopy and QA software, 100 mm Pb shields, LABSOCS efficiency calibration software.

17.4 % detector, with HV supply and amplifier bought 1987

37 % detector plus other components and software 2003

Brief description of method and applications (include comment on level of R&D vs. production):

The BGS high-resolution gamma spectrometer is capable of detecting and measuring gamma-ray activities of radionuclides with gamma energies in the ranges of 50 to 3000 KeV.. Specific gamma-ray energies are produced by each radionuclide and these produce peaks in each spectrum collected. The total number of counts in each peak are processed by software algorithms and reported as radionuclide concentrations in Becquerels per kilogram (Bq kg^{-1}).

Most analysis can be performed using existing protocols. However, calibration is feasible for almost any sample type using Labsocs but requires R & D to set up the system and ensure suitable reference materials are available.

The technique is applicable to the analysis of all gamma emitting radionuclides including natural K, U and Th series and anthropogenic radionuclides such as ^{137}Cs and ^{60}Co. Specific applications include assessment of radioactivity of phosphogypsum, environmental monitoring of contaminants, use of natural radioactivity for geological and soil mapping, radon-related research, analysis for assessment of radiation dose.

Near future investments (planned/expected/required): Installation of automatic liquid nitrogen cooling system for detectors planned (early 2006?)

In 2006-2008 the activity is expected to A: increase, B: decrease, C: stay on todays level (A/B/C): C

Is the activity wholly or partly accredited?: No

Comment if yes: However, accreditation is planned in near future

Participation in proficiency testing – number of tests per year for activity: 1

	External contracts	*Internal contracts*	*Total*
Number of samples analysed per year:	150	100	250
Income received per year (€):	21800	3600[1]	25400

Sample volume in % of total volume at laboratory: 0.5

Instrument utilisation (hours per year): 7800[2] *Theoretical max. utilisation:* 8760[3]

Man years on activity: 0.15 *Staff costs on activity (€):* 8700

Expenses on service contracts in €/yr: 0[4]

Direct costs of activity €/yr (excluding service contracts): 1000

Additional Comments

[1] Internal SB work normally forms part of project tasks. At present this is not unit costed but would be taken from staff time allocated by the project. The cost reflects an estimate of the staff time required for the analysis at cost.

[2] Utilisation is high since samples can be tested for long periods to achieve better counting statistics. Capability is actually higher since samples could be tested for shorter periods if there was an increased workload.

[3] The theoretical max utilisation is 100 %. However, most effective use of the instrument is not realistically achievable without automatic sample changing. Auto sample handling would require significant modification to the lead shield around the detector. In reality, with manual sample changing, the throughput depends on staff availability and willingness to change samples out of normal office hours. Samples may be counted for longer than necessary because it is not practical to change them, so the equipment is in use but not always at maximum efficiency.

[4] We do not have a service contract but have had to pay for manufacturer support on an ad hoc basis. This has included two repairs to the older detector and the need to hire a replacement to cover external contract work. We have also paid for specific training in hardware and software use. The costs of repair and hire have not been included the direct costs (excluding service contracts). These refer only to consumable costs. Since the older detector was purchased repair and hire costs, averaged over the years, would amount to about €500 per year. Repair charges form only a small fraction of this amount.