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Serpentinite deposits at Altermark: preliminary evaluation of dimension-stone potential

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REPORT

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Serpentinite deposits at Altermark: preliminary evaluation of dimension-stone potential

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Summary:

The Altermark area exhibits several types of serpentinite, most of them of commercial interest. Some of the deposits (especially Ellenhågen) may be technically exploitable, and there is a reasonable potential for the extraction of large blocks.

Market price for serpentinite is generally low, but with a possibly important exception regarding large commercial blocks.

Due to the market situation, the production of serpentinite blocks in Altermark is considered to be possible, but involves a high risk. Proposals for further investigations are given.

Keywords: Mineral resources	Bulding stone	Dimension-stone
Serpentinite		

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Building stone –general introduction

1. INTRODUCTION

Several lens shaped serpentinite bodies occur in the Altermark mining area. Some of these may be of dimension-stone quality, and from the Norwegian Talc's point of view, it would be of some interest to investigate their potential as such, even though the production of dimension-stone would be marginal to the company's regular activities. This report gives a preliminary evaluation of the serpentinites.

The mining area was visited in September 1999. Several samples from drill cores and one large sample block were cut and polished at NGU Løkken. To get an idea of the market for serpentinite, samples were shown to Einar Gjertsen (Granit-Kleber AS), who gave his opinion on the market possibilities. Furthermore, a quick market survey was carried out on the internet, comparing serpentinite prices with other types of dimension-stone.

2. TYPES OF SERPENTINITE

Several varieties of serpentinite occur in the area, all in shades of green. Thirty-three drill core samples were screened and grouped into commercial varieties, in order to get an impression of the distribution of commercial types in the area (Fig. 1). The drill cores are all from serpentinite bodies close to the mine.

The cores were grouped into the following categories[1]:

- Type 1: 'mottled' light green serpentinite with abundant veins and patches of carbonate (7 samples; fig. 1)
- Type 2: homogenous, dark green serpentinite (3 samples; fig. 2)
- Type 3: heterogeneous 'veined' serpentinite, green and grey (12 samples; fig. 4)
- Type 4: 'mottled' bluish grey and green serpentinite (7 samples; fig. 5)
- Type 5: greenish black, magnetite rich serpentinite (4 samples; fig. 3)

Except type 4, all of these varieties are common on the international market. The 3 first types are comparable with the Sparbu serpentinite (Nord-Trøndelag), which has been produced for 30 years. Type 4 is somewhat different from most commercial types on the market, and may be particularly interesting. Type 5 has a dark appearance, and is considered to be of less market value.

All drill cores are whole and sound, indicating that the spacing of fractures is wide.

In addition to the drill cores, a large sample of 'fresh' serpentinite was collected and cut and polished at NGU Løkken. The sample was predominantly of type 4 quality (fig 6).

[1] The transition between the categories is diffuse, and this division must be regarded as preliminary.

3. DEPOSITS AND QUARRY SITES

Several serpentinite bodies were visited. Among these, the one closest to the mine (Ellenhågen) seems most interesting. The deposit forms a small hill, which seemes interesting with respect to both spacing of fractures and volume of available rock. However, no final conclusions on block size and yield can be reached until a trial quarrying has been carried out.

On the weathered surface, it is difficult to differentiate between the colours/types mentioned above, and sampling of 'fresh' rock will be necessary.

4. MARKETS

Since pricing of dimension-stone is highly dependent on fashion, personal taste and fluctuating market trends, it is difficult to estimate how 'attractive' a specific rock type would be. Prices for raw blocks may vary from 250 to 2000 USD/cbm, depending predominantly on the colour and structure of the rocks.

One of the best ways to get an indication of market price is to compare with other stone types on the market. As prices often are carefully guarded by the suppliers, this may be a difficult task. However, there are some suppliers who make their lists of prices public via the internet.

In today's world production of serpentinite as dimension-stone, India is the most important country. Indian serpentinites are marketed under various commercial names such as *Guatemala Verde*, *Space Green*, *Magic Green* etc. All these types are green with abundant carbonate veins, thus comparable with the type 1 – 3 from the Altermark area. Other serpentinite types frequently occurring on the international market include certain 'classic' Italian types and 'new' varieties from Taiwan.

In fig. 7, 8 and 9 prices of different dimension-stones for large and small raw blocks and polished slabs are plotted, showing the price level of serpentinites compared with other types (USD FOB Indian port). For small raw blocks (USD 300) and polished slabs, serpentinites belong to the cheapest segment in the market. However, the price increase significantly for large raw blocks (USD 900), probably mirroring some general problems of obtaining large blocks from serpentinite deposits. Thus, production of serpentinite may generally be compared with the production of low-priced marble, but can be more profitable in the cases where one can produce a high proportion of large blocks.

In addition to the search on the internet, Einar Gjertsen (managing director, Granit-Kleber AS) was asked for his opinion on the market possibilities for the Altermark serpentinite. His conclusion is fairly similar to the above mentioned, that green serpentinites essentially meet high competition on the market and are low priced. However, he was of the opinion that the bluish grey variety (type 4) differ from the most common types, and may therefore obtain higher prices.

It seems fairly obvious that a production of serpentinite blocks would depend on export, since the use of serpentinite in Norway is limited. For example, serpentinite will probably not be an alternative for exterior paving, cladding and for monuments, areas where granite is preferred.

5. CONCLUSIONS AND RECOMMENDATIONS

- The Altermark area exhibits several types of serpentinite, most of them of commercial interest.
- Some of the deposits (especially Ellenhågen) may be technically exploitable, and there is a reasonable potential for the extraction of large blocks.
- Market price for serpentinite is generally low, but with a possibly important exception regarding large commercial blocks.
- Due to the market situation, the production of serpentinite blocks in Altermark is considered to be possible, but involves a high risk.

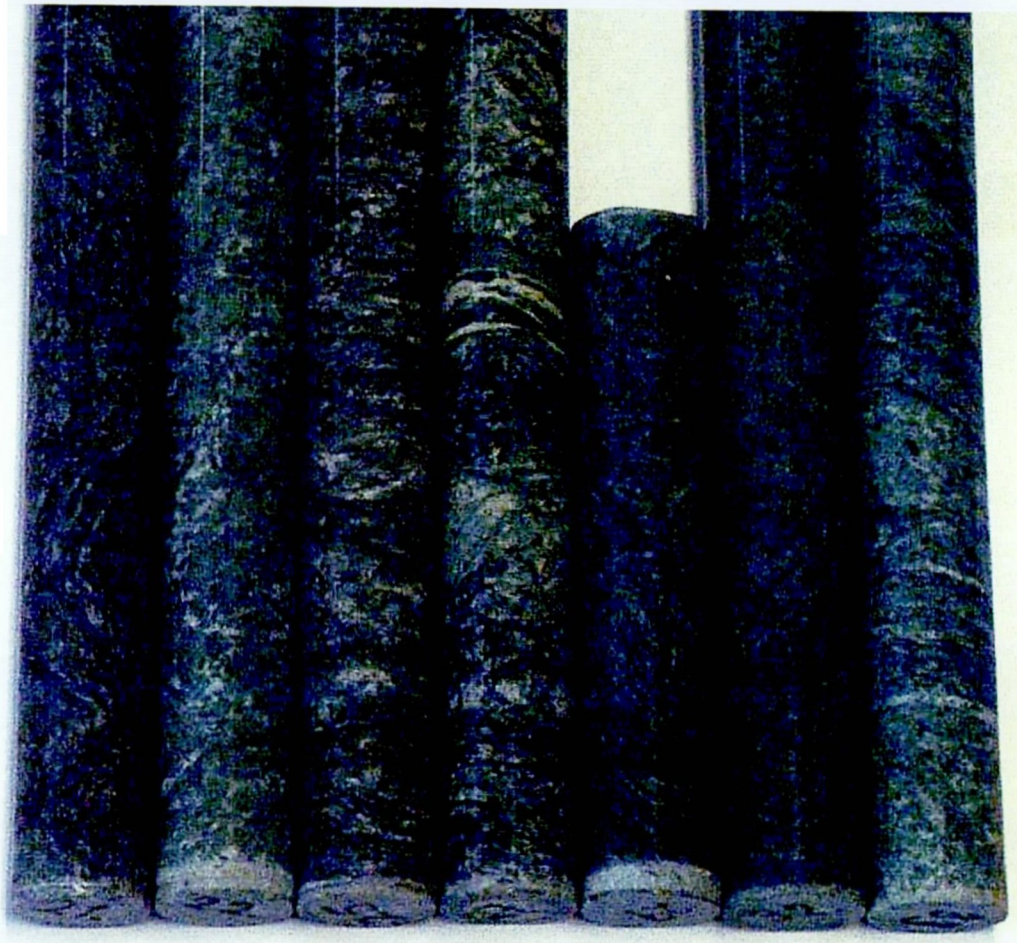
Before any further steps are made, the Norwegian Talc AS should consider this uncertainty – that the chances of establishing a commercial profitable activity on block production is probably less than 20 %.

If decisions are made to go on with investigations, we will suggest the following:

- Detailed mapping and sampling of the Ellenhågen deposit (sampling by core drilling or blasting f.ex. in 20 metres interval)
- Production of polished slabs from the samples
- Mineralogical investigations (mineral composition, asbestos)
- Trial quarrying, preferably by diamond wire sawing
- Physical and mechanical testing of samples from trial production
- Establish contact with Norwegian and foreign companies (raw block customers)

Mapping, sampling and mineralogical investigations could be carried out by the company's own personnel. NGU can make polished slabs, and else be helpful with advises, if needed. For trial quarrying, a professional company (either dimension-stone producer or diamond wire specialist) should be engaged in order to secure a best possible result.

Fig. 1
Core drill samples of type 1 serpentinite, Altermark. Number of drillhole and depth are given below each sample. The diametre of the cores is 35 mm. Please note that the colour may deviate from the original.

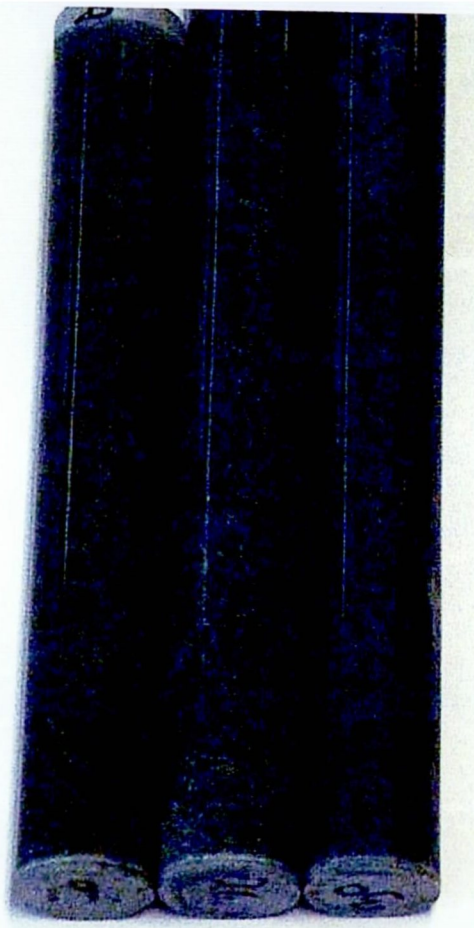


21	22	25	27	29	32	33
9501-2	9501-2	9501-2	9502-1	9502-1	9502-H1	9502H1
16m	26m	53m	16m	34m	5m	13m

sample
drillhole
depth

Type 1: 'mottled' light green serpentinite with abundant veins and patches of carbonate.

Fig. 2
Core drill samples of type 2 serpentinite, Altermark. Number of drillhole and depth are given below each sample. The diametre of the cores is 35 mm. Please note that the colour may deviate from the original.



19	26	30
9501-2	9501-2	9502-1
5m	64m	42

sample
drillhole
depth

Type 2: homogenous, dark green serpentinite

4	11	13	14
9101	9103	9103	9103
64,5m	5m	17,5m	22

sample
drillhole
depth

Type 5: greenish black, magnetite rich serpentinite

Fig. 3
Core drill samples of type 5 serpentinite, Altermark. Number of drillhole and depth are given below each sample. The diametre of the cores is 35 mm. Please note that the colour may deviate from the original.

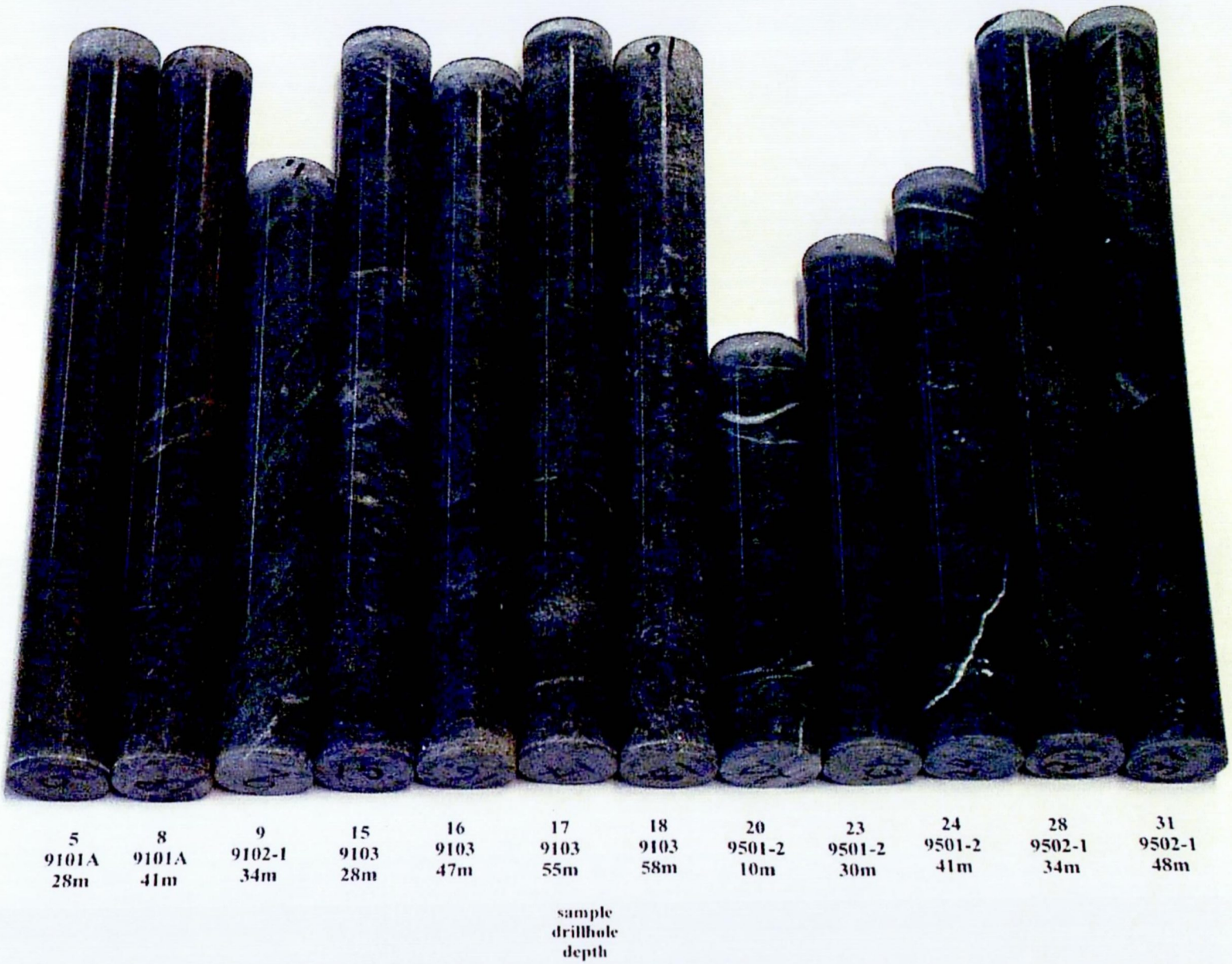
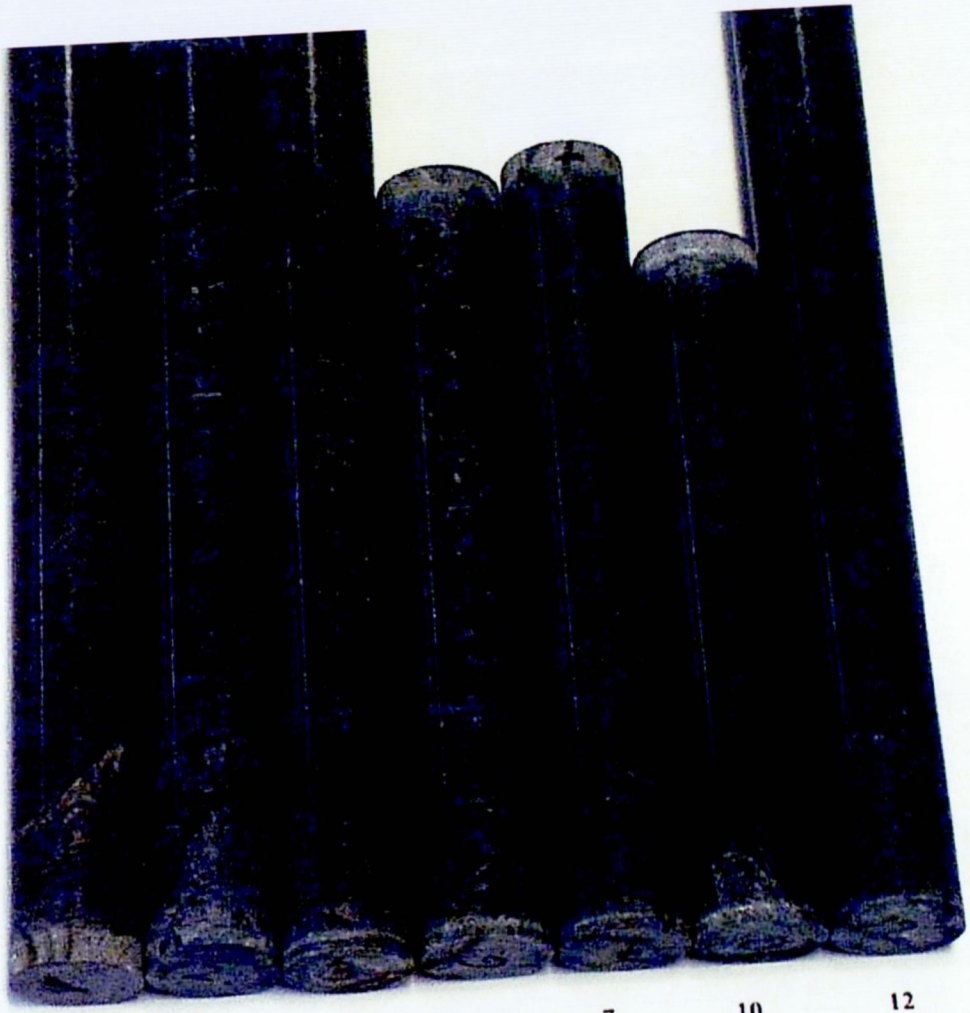


Fig. 4
Core drill samples of type 3 serpentinite, Altermark. Number of drillhole and depth are given below each sample. The diametre of the cores is 35 mm. Please note that the colour may deviate from the original.

Fig. 5
Core drill samples of type 4 serpentinite, Altermark. Number of drillhole and depth are given below each sample. The diametre of the cores is 35 mm. Please note that the colour may deviate from the original.



Type 4: 'mottled' bluish grey and green serpentinite

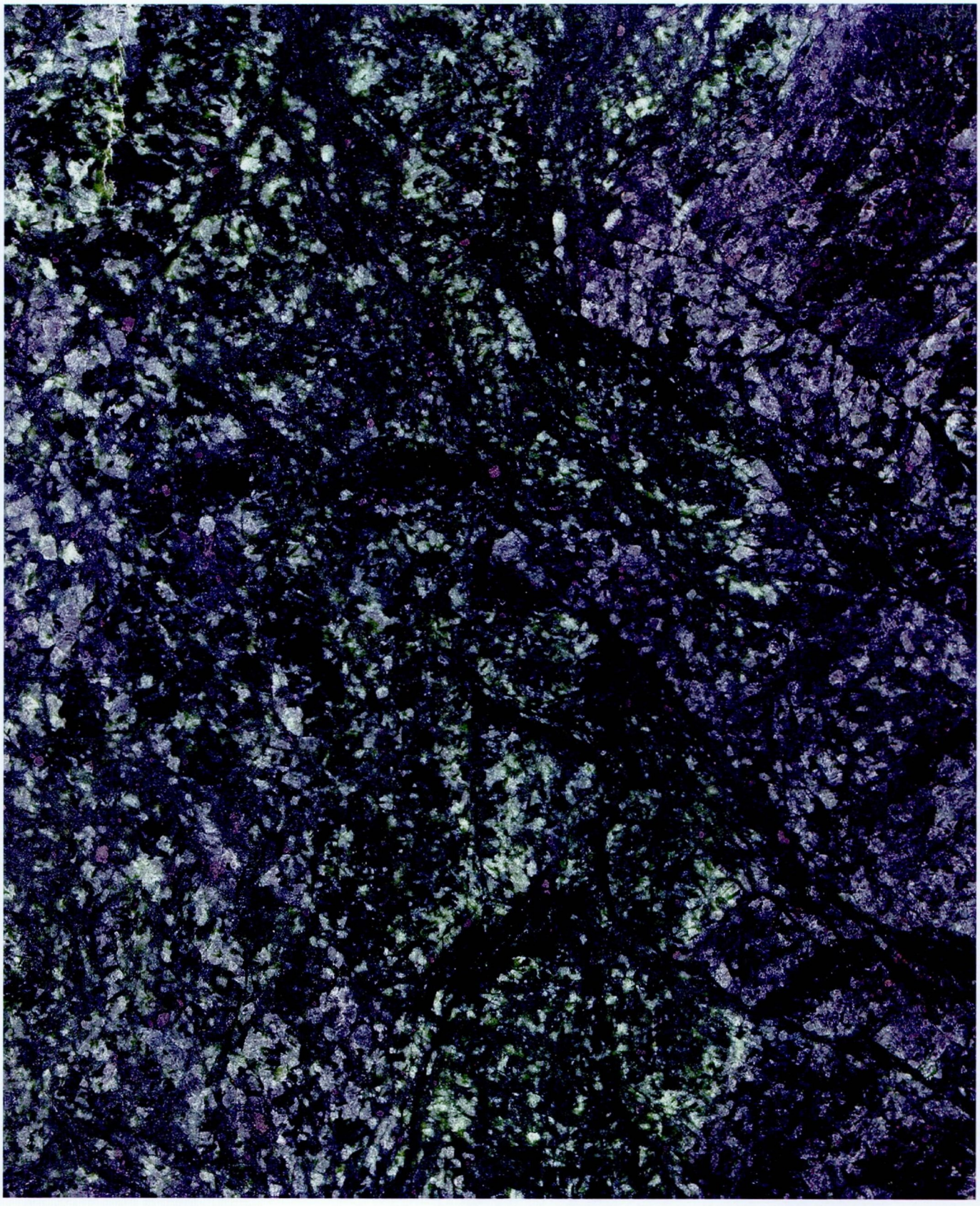


Fig. 6
Polished slab of serpentinite, Altermark. Size 1:1. Colour may deviate from original.

Fig. 7
Price examples of different Indian dimension-stone types, large raw blocks.
Commercial names of the included serpentinites are SREENATHJI GREEN, SPACE GREEN and MAGIC GREEN (prices marked by circle).

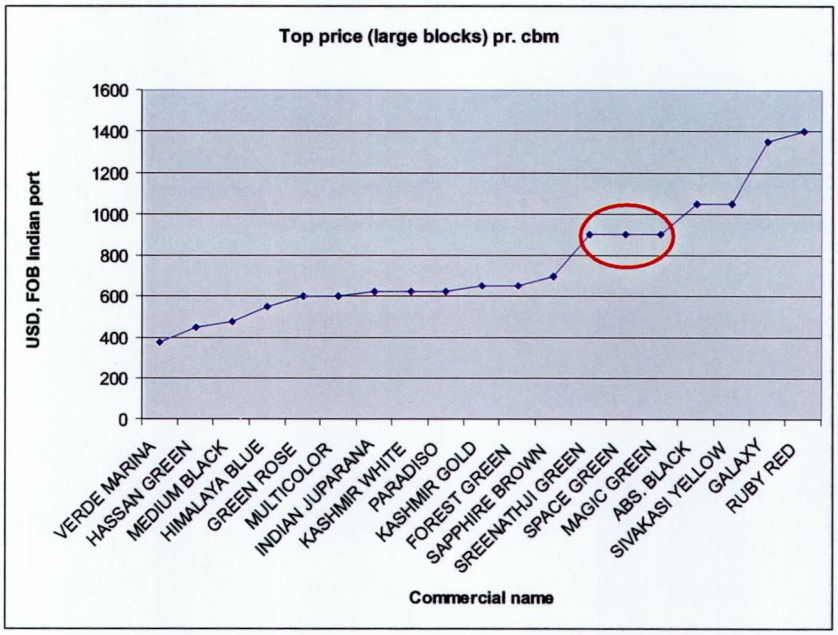


Fig. 8
Price examples of different Indian dimension-stone types, small raw blocks.
Commercial names of the included serpentinites are SREENATHJI GREEN, SPACE GREEN and MAGIC GREEN (prices marked by circle).

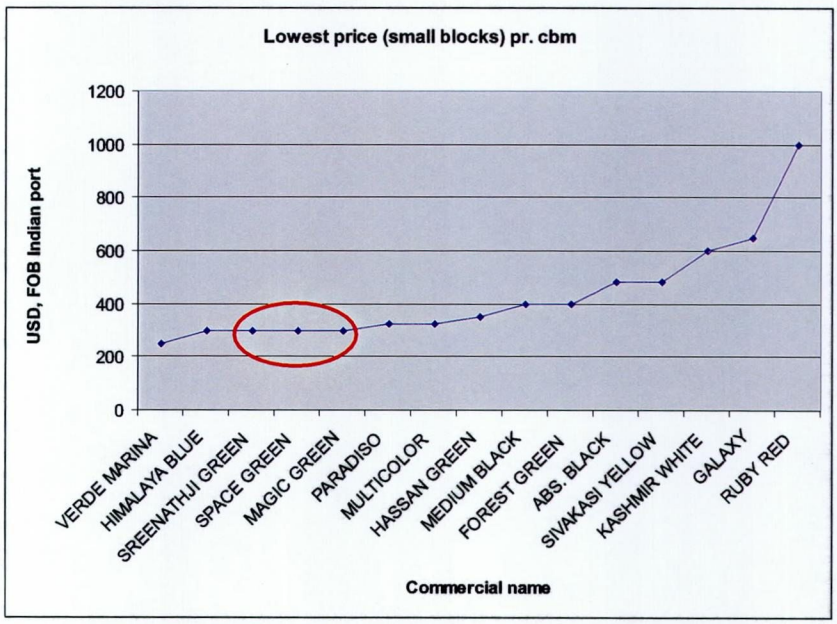
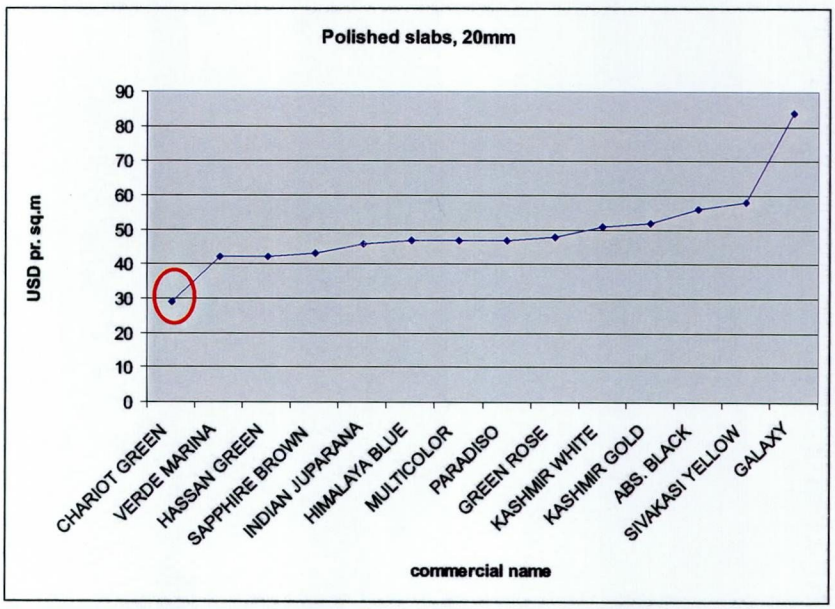


Fig. 9
Price examples of different Indian dimension-stone types, polished slabs.
Commercial names of the included serpentinite is CHARIOT GREEN (price marked by circle).



Appendix 1: Building stone –general introduction

Building stone differs from other mineral resources in several ways. First of all, stone quarrying is about the art of collecting whole, massive pieces of rock, without the need for crushing and grinding and separation of individual minerals. Furthermore, stone processing does not include removal of 'unwanted' components from the rock; it simply deals with a more or less advanced way of shaping pieces of rock into finished products. In addition, the market for stone products depends more on the consumer's personal taste and on fashion trends than the chemical and physical quality of the material concerned.
In many places around the world, the stone industry is based on the collection and shaping of field stones and simple quarrying of soft and hard stone for local building purposes. For small-scale, local-market production of stone, the basic requirements are rocks that are easily worked with a minimum of labour. An attractively coloured granite is not of commercial interest if it takes an excessive number of working hours to shape a block or a brick for construction. A 'boring', grey granite may, however, be very interesting if the cleavage properties facilitates the shaping of the blocks. This perspective differs completely from the search for stone for the international market. Most of the export quality stone of the world ends up as polished slabs on floors, walls and as tombstones. The aesthetic aspect (e.g. the colour and structure of the rock) is here far more important in the pricing of stone than physical properties. Predominantly, rare colours such as blue, yellow, pure white and deep black are highly priced, whilst rocks of more 'ordinary' colours obtain lower prices. For raw blocks, the most exclusive rocks may be 20 times more expensive than the cheapest.
All over the world we have seen, during the last decades, an expanding business in stone, both for local/domestic and for international markets. This is not only because of a short-term fashionable trend, but rather more a 'catching up' on 70 years of concrete hegemony in construction.
Building stones are often classified according to their technical quality and usability. A standardised, international classification scheme does not exist, but it is common to differentiate between massive stone (extracted in large blocks) and slabby stone, extracted as slabs which are cleaved along a planar structure, such as sedimentary layering or metamorphic foliation. Massive stone is further divided into 'soft' varieties such as carbonates and serpentinite, and 'hard', essentially quartzo-feldspathic rocks.

The most important aspect in the exploitation of natural stone deposits is the need for extracting large and whole blocks and slabs of rocks with a uniform quality. This is done by wedging, careful blasting and primary sawing, or a combination of these methods. Sawing, especially by diamond wire, is most applicable to rocks with low or intermediate hardness, such as limestone, marble, slate and serpentinite, but is also widely used for feldspathic igneous rocks and, to some extent, also for granites. However, blasting and wedging is still the most common extraction method for hard siliceous rocks. Some of these rock types have excellent natural splitting properties due to more or less visible structural anisotropic features, such as directionally distributed minerals or microfractures. Experienced quarry workers know how to make use of these directions in order to facilitate the extraction process. The structural features are also of importance to the commercial value of the finished products. Foliated or layered rocks will obviously have improved technical properties when cut parallel to the lamination instead of perpendicular to it. In addition, the colour and structure, which contribute to the aesthetic quality, vary according to cutting directions. In some extreme cases, rocks must be cut in a specific direction to have any commercial value at all, such as the Norwegian larvikites.
Another important aspect in the production of rough blocks for the international market is the need for heavy machinery in the quarries. A standard size for trade blocks is 2.4 x 1.2 x 1 m

(ca. 8 tonnes). Most suppliers will be asked for even bigger sizes, up to 30 tonnes, to feed the giant frame saws in Italy or other countries producing finished products. The blocks should be well-shaped and rectangular, with no veins, cracks or inclusions. For small blocks and blocks with such 'faults', the price may be reduced by up to 70% if one is fortunate to find a buyer for them.
The need for large blocks creates a waste problem in natural stone quarries, and generally the percentage of waste is well above 50%. In some Norwegian quarries, it may be as high as 95%. The proportion of waste is a good indicator of extraction costs, which in Norway vary from USD 150 to USD 1000 per m^3 for commercial blocks, reflecting differences in uniformity, fracture density and splitting properties. Only the most exclusive rock types can be produced at such a high unit cost. For most granites, prices (per m^3) are lower than USD 500, and thus the waste ratio should be below 80 % and the deposits homogenous and massive.
The varying price for raw blocks is highly dependent on the colour of the rocks; rare colours give higher prices on the world market. Blue, yellow, deep black and pure white are among the most expensive colours, whilst pink and grey rocks are low-priced. Generally speaking, all rocks showing an attractive play of colours, such as iridescence in feldspars, are highly priced.

Given the complex market mechanisms for natural stone, including local needs for raw materials, as well as trends and behaviour of the global market, some considerable knowledge of markets for finished products is a prerequisite in geological investigations of stone deposits. In any case, there are some important geological aspects that need to be focused upon, including:

- Geological aspects influencing *the uniformity of rock colour and structure*, such as veins and dykes, inclusions and segregations, foliations and layering and other structural elements.
- Geological aspects influencing *the block and slab size*, such as fracture density, folds, 'open' foliations, remnant stress fields and weathering and deloading features.
- Geological aspects influencing *the quality of the rocks*, in the shorter or longer terms, such as deteriorating minerals and minerals causing staining of the rock (e.g. sulphides and oxides), porosity and mineral texture.
- Geological aspects influencing *the workability of the rocks*, such as preferred orientations of minerals and microfractures.
- *Geometry and size* of the deposits

The testing of physical properties of rocks can be of assistance, especially for the documentation of quality to customers and end-users. A variety of standardised tests exist, covering the strength of the rocks to loading and other mechanical influence, to resistance to weathering and chemical attacks. At present time, test methods and product requirements are being harmonised at a European level. However, the tests are not of any significant help for evaluating the commercial value of the deposits.