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Geological mapping of a potential extraction area for hard-rock aggregates, Gulestø, Bremanger, Sogn og Fjordane

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REPORT

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Title:
Geological mapping of a potential extraction area for hard-rock aggregates, Gulestø, Bremanger, Sogn og Fjordane

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Client:
EUROVIA, NGU

County:
Sogn og Fjordane

Commune:
Bremanger

Map-sheet name (M=1:250.000)
Florø

Map-sheet no. and -name (M=1:50.000)
Bremanger 1118 4

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Gulestø 290700.6852800

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295900

Person responsible:
Øystein Nordgulen

Summary:
Geological mapping of a planned extraction area for hard rock aggregates has been carried out at Gulestø, Bremanger for EUROVIA. A number of hand-specimens were collected and thin-sections of these rocks were subsequently examined under the microscope.
The bedrock of the area consists of fine-grained, Devonian sandstone with thin beds of siltstone/claystone. The grain size ranges between 0.5 mm and 0.05 mm for most of the rocks. The sandstone beds strike between 020° and 040° (i.e. c. NE-SW) and dip at 30° towards the southeast. Joints are transecting the rocks in several directions.
Field investigations and microscopic examination indicate that the sandstone is well suited for aggregate production. The homogeneous appearance of the rocks leads us to conclude that it should not be necessary to conduct a drilling programme in the planned extraction area.
NGU recommends that the area should be further examined by mechanical testing.

Keywords: Ressurskartlegging	Pukk	Mineralogi
Mikroskopering		

CONTENTS

1. INTRODUCTION

In 1996 NGU located several areas in Bremanger municipality where natural conditions are suitable for establishing major coastal facilities for aggregate production. The Gulestø area was one of those that seemed most favourable. At a meeting held at NGU, Trondheim, July 3rd 2001, plans for an extraction area of hard-rock aggregates at Gulestø were discussed between EUROVIA and NGU.
Based on that meeting, NGU offered in a letter dated August 24th 2001, to carry out investigations in the area including geological mapping and sampling for mechanical testing of the rocks. EUROVIA accepted NGU's offer to carry out geological mapping as a first phase of the investigations.
The mapping was carried out during a few days in late September, 2001, by Svein Gjelle, NGU.

Trondheim, 16th of November 2001
Project Group for Building Raw Materials

Peer-Richard Neeb
Project Manager

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Senior Geologist

2. GEOLOGY OF THE GULESTØ AREA

2.1 Field investigations

The Devonian rocks of the Gulestø area consist of thick, greenish-grey, fine-grained sandstone beds alternating with dark grey, very fine-grained, mica-bearing siltstone or claystone beds, usually 1 to 15 cm thick. The sandstone beds are usually a few metres thick in contrast to the cm-thick beds of siltstone/claystone. The thickness variation between the sandstone and the siltstone/claystone is not mappable.

Fig. 1. Thin, dark, siltstone/claystone layers in fine-grained sandstone from a road-cut about 800 m west of Gulestø.

The rocks have a reddish-grey weathering surface only a few mm thick. The siltstone/claystone layers are schistose whereas the sandstone benches are more massive and in some places the bedding is difficult to observe. In new road-cuts, a fine lamination and other sedimentary structures can be observed.

Fig. 2. Sedimentary structures in the sandstone.

The beds strike between 020° and 040° towards northeast and dip at about 30° towards the southeast. This means that the beds cropping out in road-cuts due west of the Gulestø farm are striking right through the area of the planned quarry. This is illustrated on the map by red lines showing where a few selected bedding planes cut the terrain surface. As the beds only show negligible variations along strike, the road-cuts west of Gulestø are a convenient place to study the rocks of the planned extraction area.

Fig. 3. The sandstone beds in these road-cuts due west of Gulestø are striking towards the southwest into the highest part of the planned extraction area.

Joints are transecting the rocks in several directions. Those visible on aerial photos are drawn on the map as thick black lines. The most conspicuous are the NW-SE oriented joints. They have created escarpments and gorges that are dominating features in this sandstone terrain. A vertical E-W oriented joint trend and a gently (30^{o}) west-dipping, N-S oriented set of joints are also recorded in the area.
A few of the joints are filled with coarse-grained quartz and/or calcite. These fillings are usually less than 2 cm thick.

Fig. 4. Bedding and joints. The hammer is lying on a bedding surface that is dipping at 30° towards southeast, i.e., away from the viewer and into the picture. To the right of the hammer a gently west-dipping joint can be seen, and beneath the hammer there is a vertical E-W-oriented joint surface. The trace of the bedding is seen on both joint surfaces.

2.2 Microscopic examination of thin-sections

Sixteen hand specimens were collected, and thin-sections were produced and subsequently examined. The result of this examination shows that the rocks have a fairly constant mineralogical composition. The main rock-forming minerals are quartz, plagioclase, potash feldspar (microcline and orthoclase, sometimes with perthites), muscovite, calcite, chlorite, epidote and clinozoisite. Other minerals observed in thin-sections include biotite, sphene, rutile, apatite, tourmaline and opaque minerals.

A visual estimation of the mineralogical composition of the sandstone shows:

- 50-60 % quartz
- 10-25 % feldspar
- 5-15 % muscovite (white mica)
- 0-25 % calcite
- 1-5 % epidote and clinozoisite
- 1-15 % chlorite

Fig. 5. Photomicrograph of a thin-section of a typical sandstone bed (upper right half) in contact with a siltstone/claystone bed (lower left half) showing contrasting grain size. The grain size of the sandstone near the lithological boundary is smaller than in most of the examined thin-sections. 1000 micrometres = 1 mm.

The thin-sections show that the grain size is usually less than 0.5 mm in the sandstones, but some mica crystals can reach up to 0.7 mm. The common grain size for quartz, feldspar, calcite and epidot is between 0.5 and 0.05 mm.
The quartz grains are angular. They are rather evenly distributed throughout the rock, even though there is a faint layering defined by parallel-oriented white mica and thin laminae with a very fine-grained texture, alternating with thicker layers that have a slightly coarser grained texture.

The feldspar grains are also angular. The small grain size makes it difficult to distinguish the feldspar minerals from each other and from quartz. Because of this, it is difficult to estimate the modal percentage of each mineral with any accuracy.
The amount of white mica present varies but usually it lies between 5 and 10 % and with a slight tendency for higher contents in the most fine-grained layers.
Calcite occurs both as detrital grains and as matrix, and also as fillings in joints. Only one of the thin-sections is devoid of calcite. This sample was collected from the lithological contact with a claystone layer (which, by the way, also is lacking calcite). The normal case is that the sandstone is calcite-bearing, but the content of calcite is varying within quite wide limits (0-25 %).
Epidote, clinozoisite and chlorite are present in all the thin-sections that have been studied. For epidote/clinozoisite the content is <5 %, while the chlorite content usually lies in the range 5-10 %, but up to 15 % has been recorded.

The siltstone/claystone beds have a considerably higher percentage of muscovite and chlorite than the sandstone and a much lower quartz content. A visual estimation of the mineralogical composition of one of the siltstone/claystone beds gave the following result:

- 15 % quartz
- 40 % muscovite (white mica)
- 40 % chlorite
- 5 % mainly epidote and opaque minerals.

The grain size is extremely small in these thin beds, less than 0,1 mm in one thin-section and less than 0.007 mm in another.
Lack of feldspar and calcite is another feature that characterises this rock. The high content of mica and chlorite is responsible for the development of a schistosity in these beds.
The volume of siltstone/claystone in the area is low compared with the sandstone. These beds are unevenly distributed throughout the area. They are easy to see in road-cuts but harder to find elsewhere in the terrain. Most outcrops show rather massive sandstone benches, whereas the siltstone/claystone beds seem to be unexposed or crop out mostly in steep cliffs.

3. CONCLUSION

The conclusion of this investigation is that the rocks are considered to be homogeneous within the planned extraction area. The bedrock consists of fine-grained, Devonian sandstone with thin beds of siltstone/claystone. No significant geological or structural-geological variation has been recorded within the mapped area.
It should therefore not be necessary to examine the deposit with core drilling. We still recommend that the area should be further examined by mechanical testing as indicated in our original letter dated 24. August 2001.

N

Frøysjøen

Guleskjær
A 29△58
3,54

Sæleboltg

Stovedalen

Heieneset
A 29△59
3,83

Litlesommaren

Vaulemyra

Gulestø

Bjørnegjelet

Eikedalen

Gamlehjellen

Langemyra

Kyrtegjelet

Loddehjellen

Bjørkelia

Nipene

Skudalselva

Kisteloket

Sandhaugane

Bjørnemyrane

Restallmyra

Skudalsvatn
181

Kupene

Vass-stranda

Øyrane

Fossedalsvatn
342,5

Fossedalen

Ur

A

B

mo.h.
100
50
0

mo.h
300
250
200
150
100
50
0

0 100 200 300 400 500m

Legend

- Superficial deposits, mainly moraine and scree and without any observed outcrops
- Fine-grained, Devonian sandstone with thin layers of siltstone
- Trace of bedding (where bedding planes cut the terrain surface)
- Joints visible on air photos
- 30 Bedding with dip indicated
- A—B Section line
- Boundary of planned extraction area

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GULESTØA,
BREMANGER, SOGN OG FJORDANE

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

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