Petrographic analysis of Sample ES1

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Sample ES1 was collected from rock on the seafloor at the location where MS Estonia sunk.

A 4 cm x 2 cm x 0.5 cm chip of this rock (Fig. 1) was cut and sent to Vancouver Petrographics in Canada for preparation of a double-polished petrographic thin section. This is a 0.03 mm slice of the rock chip mounted on a glass slide (Fig. 1).

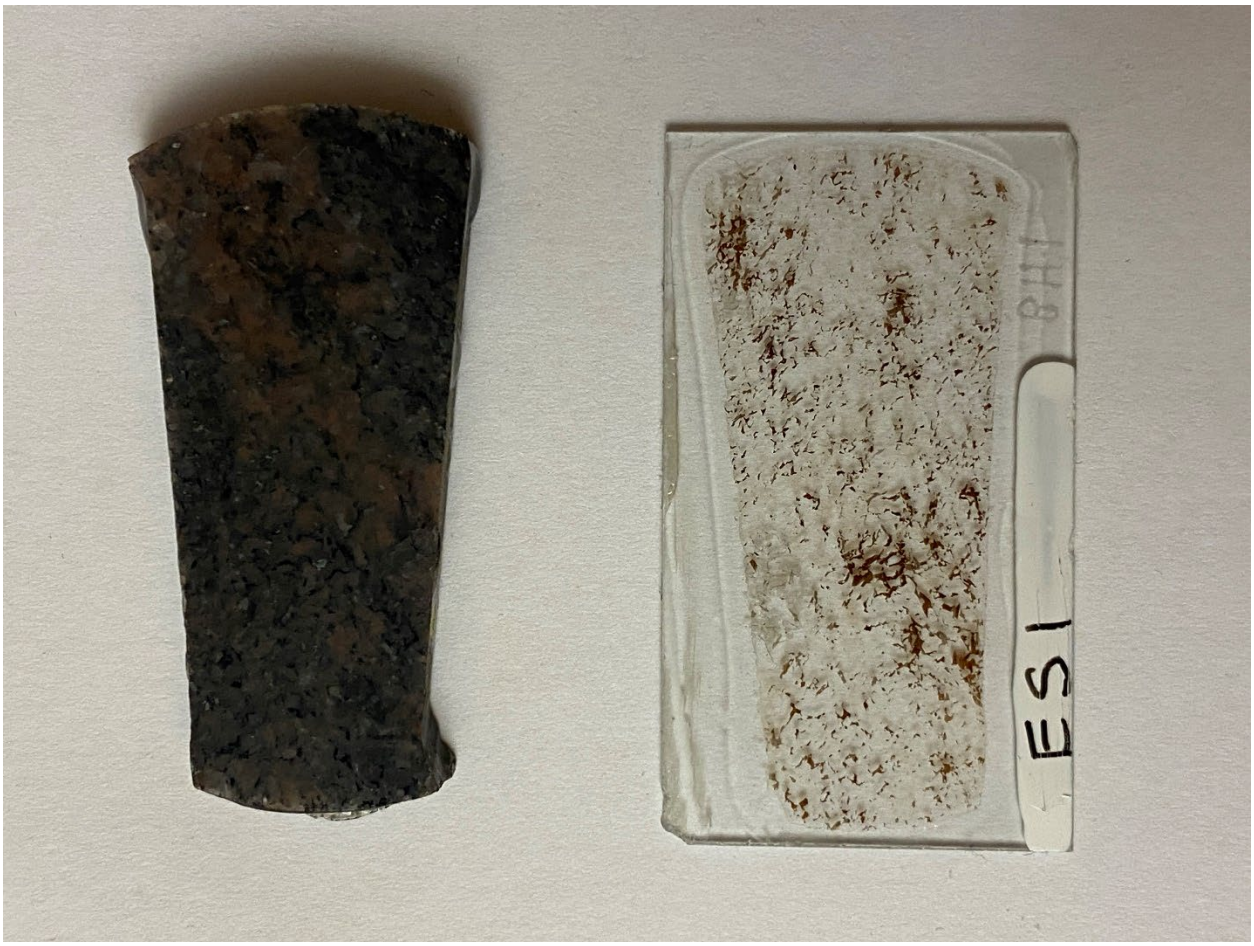

Fig. 1. 4 cm x 2 cm rock chip (left) and petrographic thin section (right) from sample ES1.

Close examination of the rock chip (Fig. 2) reveals a weakly defined banding of pinkish areas and whitish grey areas. The pinkish areas are dominated by K-feldspars, whereas the whitish-grey areas are dominated by quartz and biotite. This banding is called **gneissose banding** and is characteristic of gneiss which is a high-grade metamorphic rock.

Fig. 2. Gneissose banding in sample ES1.

The petrographic thin section was examined using a Nikon Eclipse 50i polarizing microscope at a magnification of x40 in both plane polarized light and between crossed polarizers. This is a standard technique for mineral identification. A “sensitive tint” plate was used to help visualize any preferred orientations of mineral grains.

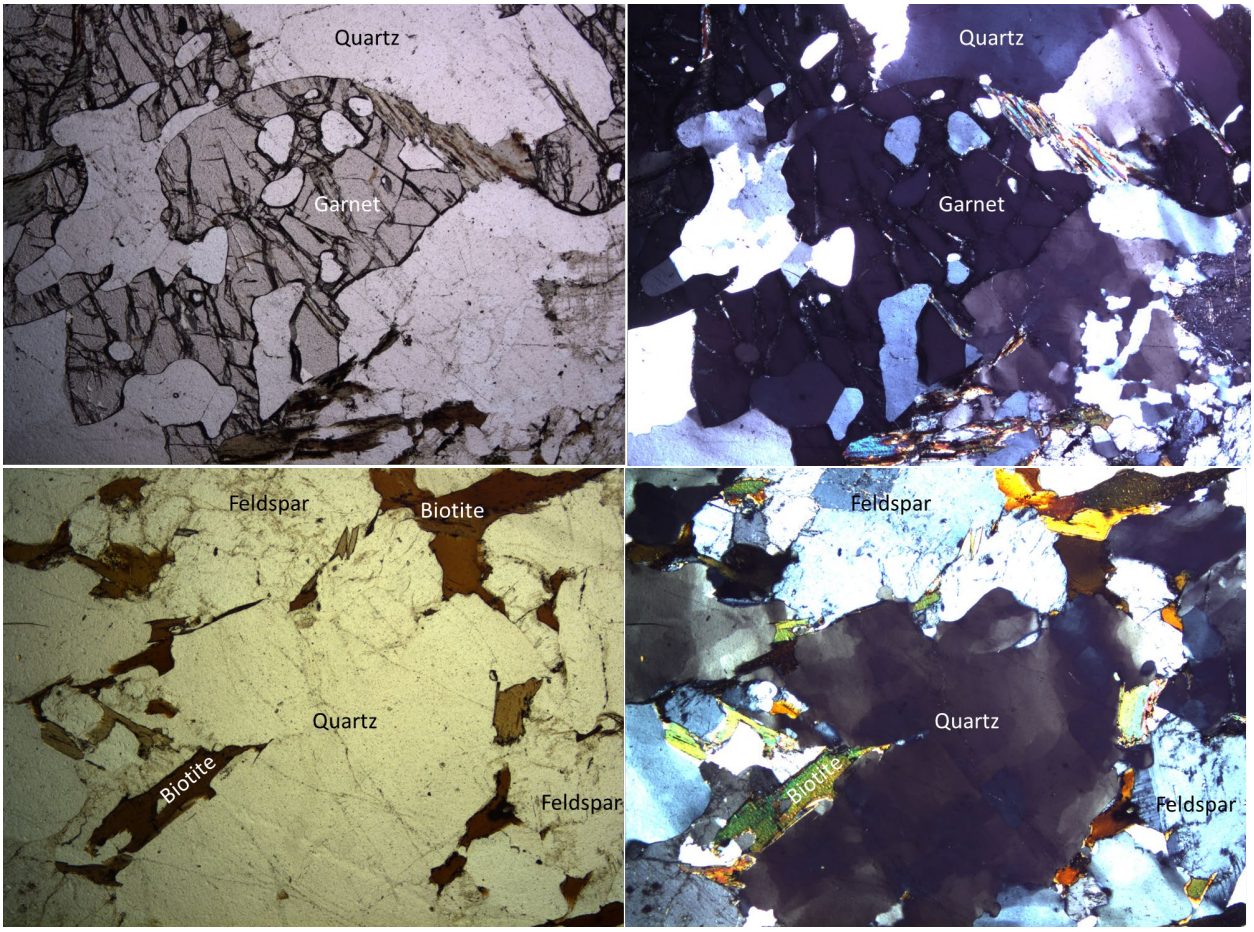

Fig. 3. Photomicrographs of 2 representative areas of petrographic thin section ES1 (x40) viewed in plane polarized light (left) and between crossed polarizers (right).

Sample ES1 was found to consist of interlocking crystals of quartz, feldspar (K-feldspar and plagioclase), biotite and garnet (Fig 3.). Quartz is colourless when viewed in plane polarized light and various shades of grey when viewed between crossed polarizers. Feldspar is also colourless in plane polarized light and various shades of grey when viewed between crossed polarizers. It is distinguished from quartz because it contains a lot of inclusions which gives it a “dirty” appearance and/or it shows twinning, which gives it a stripy appearance. Biotite is various shades of brown in plane polarized light and colourful when viewed between crossed polarizers. Garnet is greyish and has high relief (which makes it stand out) in plane polarized light. It appears black when viewed between crossed polarizers. Some biotite is partly altered to chlorite. The mineral assemblage biotite + garnet + quartz + feldspar is typical of gneiss. The mineral garnet mainly occurs in metamorphic rocks. Gneiss is a metamorphic rock.

A “sensitive tint” plate which is usually made of gypsum can be used to make it easier to visualize the internal structure of crystals. This was used to examine quartz crystals in sample ES1. Two observations can be made. The colour is undulatory (meaning that it varies within the grain). The purple-coloured crystals appear to be replacing other quartz crystals (with different colours). The former texture is called “undulous extinction” and the latter is called “grain boundary migration”. Both textures form when quartz crystals are deformed and kept at elevated temperatures for a prolonged period of time. This commonly occurs during metamorphism which is the process whereby gneisses are formed.

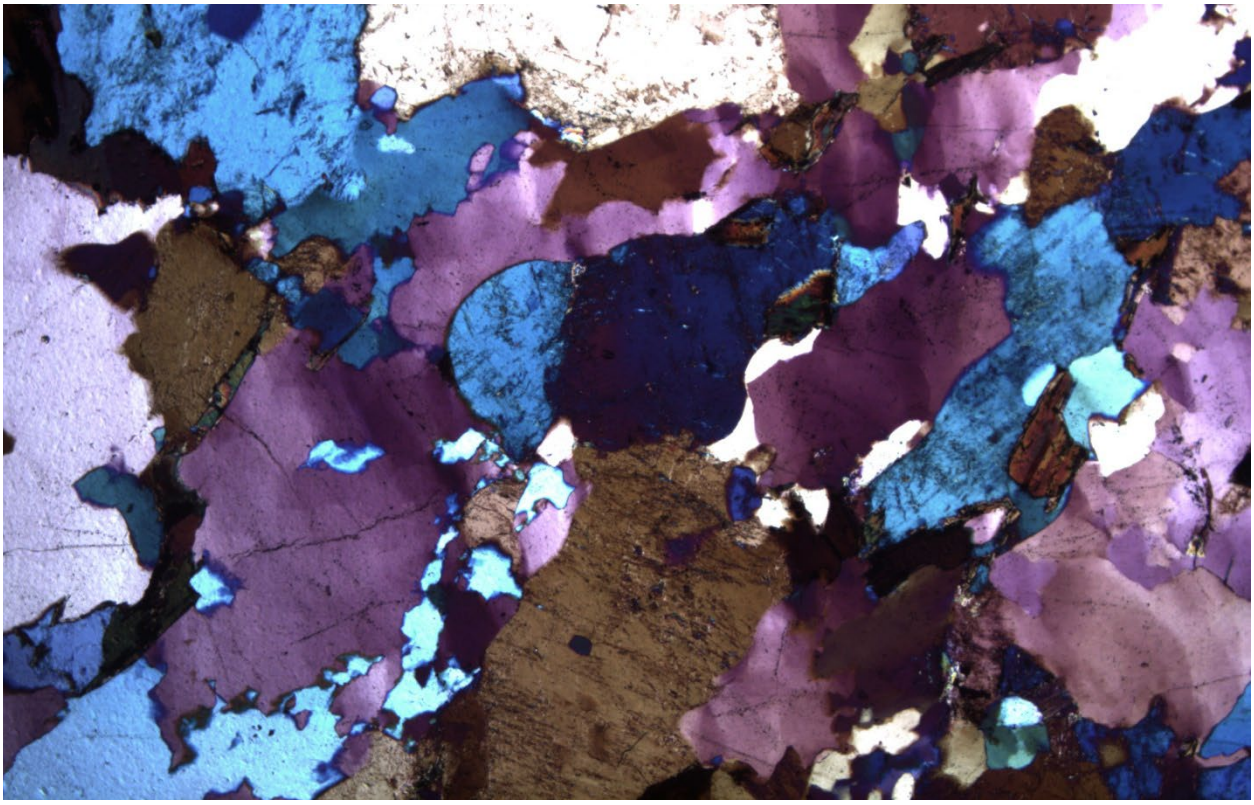

Fig. 4. Quartz crystals (purple) in sample ES1 viewed with a “sensitive tint” between crossed polarizers.

In conclusion, sample ES1 is almost certainly a gneiss. This is a very common bedrock in Finland, Sweden and Norway. It is perfectly reasonable that bedrock on the seafloor at the location where MS Estonia sunk would be gneiss.