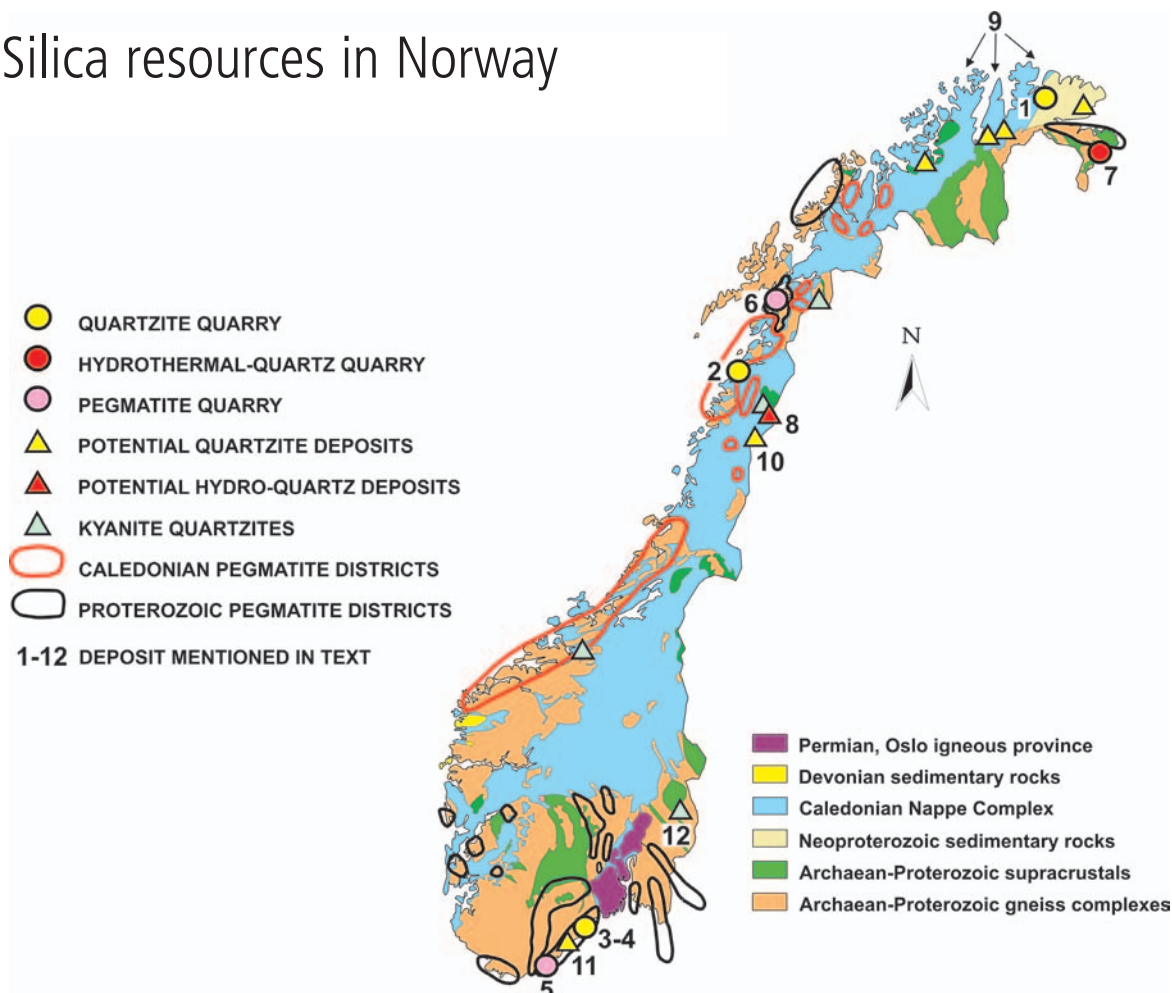




Silica resources in Norway

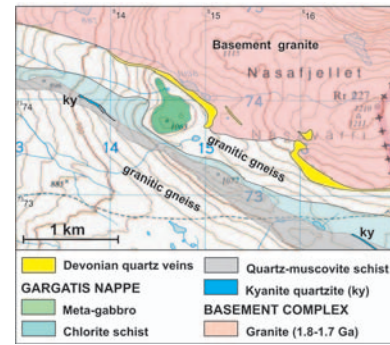


Norway has large resources of silica, including deposits of quartz sandstone, quartzite, hydrothermal quartz and pegmatite. Present production of silica from these deposits totals about 1.2 Mt, i.e. ~1 % of world production. About 0.2 Mt of the produced silica is exported, and another 0.4 Mt are imported for the manufacturing of metallurgic grade silicon and green to black silicon carbide. Quartz sandstone and quartzite used in the manufacturing of ferrosilicon and silico-manganese by the Norwegian ferroalloy industry is quarried at Elkem Tana (1 in map), Elkem Mårnes (2), Snekkevik (3) and Litangen (4). North Cape Minerals produces ceramic and glass-grade quartz and feldspar concentrates by processing granitic pegmatites at Glemsland (5). Norwegian Crystallites produces high purity quartz (HPQ) for high-tech applications. Raw materials are mined from quartz pegmatites in the area around the processing plant at Drag (6) and from a newly opened quarry in a hydrothermal quartz vein at Svanvik (7).

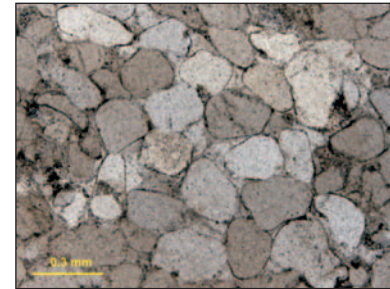
Potential resources

Over the last two decades the Geological Survey of Norway (NGU) systematically surveyed silica resources on a nation-wide scale, and several of the presently mined deposits were initially defined as a potential resource by NGU. Silica deposits of national importance include deposits of silicon-grade hydrothermal quartz at Nasafjell (8) and ferrosilicon grade quartzites along the coast of Finnmark (9), at Melkfjellet (10) and in the Sørlandet region (11). Newly discovered deposits of kyanite quartzites represent a potential future resource for high purity quartz. Presently, NGU is investigating the genesis of kyanite quartzites and HPQ pegmatites as part of its regional surveys of HPQ resources in Norway.

The Nasafjell vein deposit (8) along the basement-cover contact in the Caledonides, comprises a train of hydrothermal quartz lenses. The two largest lenses measure 15-50m x 1500m (W) and 40-100m x 1000m (E). The total resource of hydrothermal quartz exceeds 10 Mt. Mineral impurities are carbonates and minor sulphides. Elkem ASA is currently investigating the deposit as raw material for manufacturing of metallurgic grade silicon.



The largest silica resource in Norway comprises units of quartz sandstones and orthoquartzites in the Caledonides of Finnmark (9). The most prominent of these units is the late Proterozoic Gamasfjell formation that can be followed for more than 300 km. It increases in thickness from 40 m in the west to about 200 m farthest east near Vadsø, where it is estimated to contain about 10 Mt per vertical meter of quarrying. Elkem Tana recovers about 1 Mt annually of quartz sandstone from the formation.



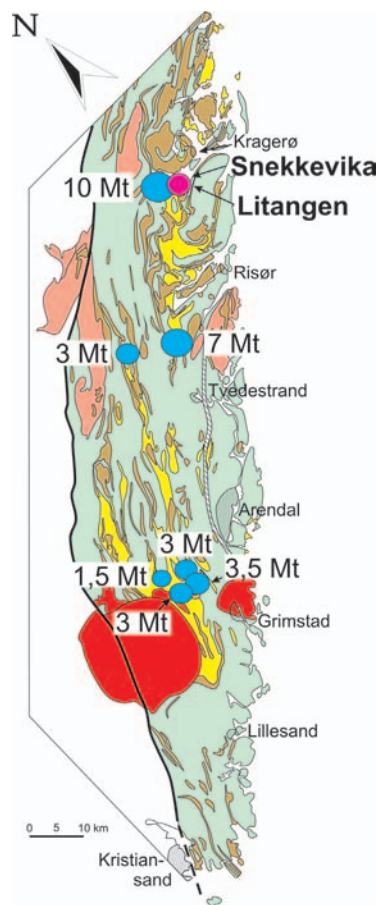
The Melkfjellet quartzite unit (10) 40 km east of the port in Mo i Rana, was recently identified by NGU. It has a potential of 10-30 Mt of good quality ferrosilicon raw material and may represent a future source for the smelter operated by Fesil ASA in Mo i Rana.



Kyanite quartzite occurs as stratabound lenses in Proterozoic volcanic sequences throughout Norway. The rock-type is composed of fine-grained HPQ (70-85%) and >15 % kyanite. The largest deposits are found in the Solør area (12) in South Norway where lenticular bodies reach dimensions of 300m x 2000m. Kyanite quartzite represents a potential future source of high purity quartz.



The quartzite units (yellow) in the **Sørlandet region** (11) have chemical qualities that make them suitable for the manufacture of siliconcarbide, ferrosilicon and silicomanganese. The individual deposits are estimated to contain open-pit resources in the range 1.5-10 Mt. Presently, the quarries at Snekkevika (3) and Litangen (4) produce lump quartz for production of silicomanganese.



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