Excursion log to the 2nd SNF Workshop, Bamble 1991.

Locality No.:

Sapphirine-cordierite-bearing metasediments at Gladstad, south of Tvedestrand

by Piet H.M. Thijssen and Diederik Visser

Gladstad, Tvedestrand 1612 II map, 32VMK64973-4958

Along the road 410 from Tvedestrand to the south there are exposures of a several hundred meters thick well-banded unit consisting of sillimanite-phlogopite-quartz ± garnet ± cordierite gneisses and schists and garnet-amphibolites with orthopyroxene in large quartz-feldspar segregations (Field, 1969; Lamb, 1981). About 700 m south of Tvedestrand, near Gladstad, at 25 meters from the junction of road 410 with the small cross-road eastwards to Bronsbu, a small dark coloured sapphirine-bearing lens occurs along this cross-road surrounded by coarse-grained quartz-cordierite, apatite-cordierite rocks and medium-grained cordierite-sillimanite-biotite-orthoamphibole rocks (Fig. 1).

The Gladstad locality is one of six sapphirine-bearing localities presently known from the Bamble area. Touret & de la Roche (1971) were the first to describe the now well-known Snaresund locality also from the Tvedestrand area. Subsequently, Lamb (1981) presented a detailed geochemical study on the Snaresund- and three other localities including the Gladstad occurrence. Recently two additional occurrences were discovered from the Ubergsmoen area. One of these, near Hauglandsvatn, will be dealt with during this excursion.

The Al-rich and silica-poor sapphirine-bearing lens consists of orthopyroxene, phlogopite, orthoamphibole, sapphirine, spinel and cordierite as major phases. Accessory minerals are rutile, ilmenite, apatite and zircon. Orthopyroxene, phlogopite, sapphirine and spinel become more abundant in the core, while orthoamphibole is the prominent mineral in the outer margin of the lens. Sapphirine occurs as corona between green spinel and phlogopite, orthoamphibole and cordierite. Orthopyroxene-sapphirine intergrowths occur frequently whereas orthoamphibole-spinel intergrowths are rare. The textures indicate the generalised sapphirine-forming reaction:

Spl + Oam ± phl ± crd -> Spr + Opx

Relict spinel grains show variable magnetite ± corundum exsolution, while sapphirine is replaced by chlorite ± hematite along cracks. Ilmenite shows exsolution lamellae and fine-grained aggregates of both hematite and rutile.

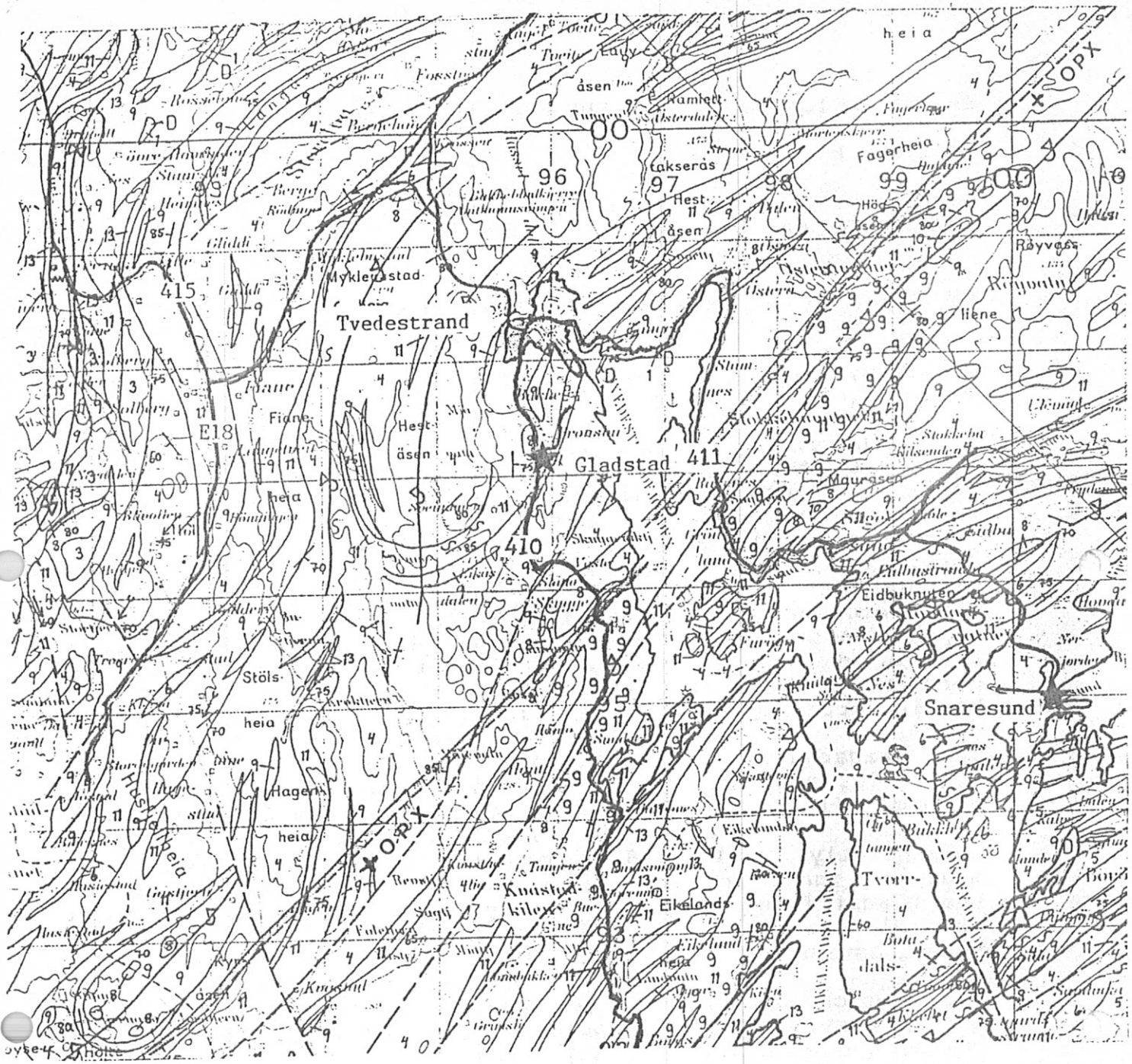

Fig. 1. Locality map of the Gladstad- and Snaresund occurrences. Geological units after Padget, 1988: Tvedestrand Bergrunnskart 1612 II (preliminary copy, N.G.U.). 1. Dolerite, diabase; 2. Pegmatite; 3, 4, 5. Granite, Granitic gneiss (with biotite and cordierite); 6, 7 Augengneisses; 8. Gabbro; 9. Amphibolite; 11. Banded gneisses; 12. Nodular gneisses; 13. Quartzite

Fluid-regime:

The $H_2O/(H_2O+CO_2)$-ratio (XH_2O) of the metamorphic fluid species H_2O and CO_2 at this locality were calculated from wet-chemical and infrared analyses of cordierite using these experimental determined Mg-cordierite-fluid partitioning data of Johannes & Schreyer (1981). Analysed XH_2O in cordierites (n=6) from the coarse-grained quartz-cordierite- and medium-grained cordierite-sillimanite-phlogopite-orthoamphibole rocks range 0.86-0.95 (x=0.91). This implies a high XH_2O of 0.68-0.96 (x=0.91) of the coexisting metamorphic fluid at this locality. Other possible fluid species like CO (c.f. Kihle, 1990) and CH_4 were not detected in the infrared spectra of the cordierites.

Origin:

The sapphirine rock occurs within a unit bearing a clear metasedimentary signature. Garnet-amphibolites may represent possible metavolcanic intercalations. The association of garnet-sillimanite gneisses, cordierite-orthoamphibole rocks and apatite-cordierite-bearing rocks types fits very well within an evaporitic depositional environment associated with rifting recently described from Mid-Proterozoic rocks of Bushmanland, south Africa (Willner et al., 1990). A possible evaporitic origin is likewise suggested for some of the cordierite-orthoamphibole rocks (Jøsang, 1966; Touret, 1969; Beeson, 1988; Faervik excursion locality No.) from both the Bamble and Kongsberg Sectors.

References:

Beeson, R., 1988: Identification of cordierite-anthophyllite rock types associated with sulphide deposits of copper, lead and zinc. Trans. Inst. Min. Metall. Sect. B: 97, B108-B115.

Field, D., 1969: The geology of the area around Tvedestrand, south Norway. Unpubl. Ph.D. thesis, University of Nottingham.

Johannes, W. & Schreyer, W., 1981: Experimental introduction of CO_2 and H_2O into Mg-cordierite. Am. J. Sci., 281, 299-317.

Jøsang, O., 1966: Geologiske og Petrografiske Undersokelse i Modumfeltet. Norges Geologiske Undersøkelse, 235, 148 pp.

Kihle J., 1990: CO_2-CO-H_2O distribution within the polymetamorphic cordierite-bearing metapelites of hte Bamble Sector, southern Norway. Geonytt 17, 64-65.

Lamb, R.C., 1981: Geochemical studies in Proterozoic high-grade gneiss terrain, Bamble Sector, south Norway. Unpubl. Ph.D. thesis, University of Nottingham.

Touret, J., 1969: Le Socle Précambrien de la Norvège méridionale. Thèse Nancy, A.O. CNRS, no. 2902, 316p.

Touret, J. & de la Roche, H., 1971: Saphirine á Snaresund, près de Tvedestrand (Norvège Méridionale). N.G.T., 51, 169-175.

Willner, A., Schreyer, W. & Moore, J.M., 1990: Peraluminous metamorphic rocks from the Namaqualand Metamorphic Complex (South Africa): Geochemical evidence for an exhalation-related, sedimentary origin in a Mid-Proterozoic rift system. Chemical Geology, 81, 221-240.