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Electromagnetic radiation studies and its implications on the regional stress field in the Caledonides of northern Scandinavia

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Electromagnetic radiation (EMR) from the earth's lithosphere occurs as pulsed radiation in a wide range of frequencies from less than 1 kHz up to about 50 MHz, and even higher. From August to September 2005 EMR measurements in the frequency range from 5 to 50 kHz were conducted in the Caledonides of northern Scandinavia (Sweden and Norway) in order to test different EMR measuring methods, which were developed in central Europe, in a different tectonic setting and with different rock types. In addition, information on orientation and magnitude of the regional stresses at several localities was achieved. Measurements covered several areas along a profile starting at the basement close to the town of Vilhelmina (Sweden) in the east through the different Caledonian rock units, to the ancient, Caledonian Baltica-Laurentia suture zone in Norway in the West (Steinfjellet tunnel).

Horizontal measurements have been applied at the earth's surface in order to determine the orientation of the major horizontal principal stress. Cross section measurements were conducted in tunnels. EMR detected underground is related to shear fractures of the secondary stress field due to the open space of the tunnel. Because the orientation of the long axis of the tunnel as well as the topographic load on top of the tunnel are known at each measuring location, these measurements can be used to derive stress magnitudes. In the working area a WNW-ESE orientation of the major horizontal principal stress and relatively low stress magnitudes could be determined except for the Steinfjellet tunnel.

Only a few in-situ overcoring stress determinations in central and northern Scan-

dinavia have been published. Preferred stress orientations are not clear from these results. Borehole breakout data from off-shore Norway, however, clearly indicate a WNW-ESE to NW-SE orientation of the major horizontal principal stress. These results are in line with focal plane solutions from the same area. They are also consistent with the results of this study, which show the same orientation. They are in contrast with the literature data from different stress determination methods applied on the eastern coast of Sweden. In that area, major horizontal principal stress has a NE-SW orientation and is often parallel with the coast line. The stress magnitudes derived from EMR are relatively small with principal stresses smaller than 2 MPa at most investigated sites. This is consistent with the low number of earthquakes which occur in the area and may be a result of the tectonic setting on a passive continental margin, in contrast to a convergent margin, such as in the Alpine area with compressive stresses of 5 or even 10 MPa close to the surface. However, comparable stresses can be assumed in the Steinfjellet tunnel, at the ancient, Caledonian continental suture of Laurentia and Baltica.