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Monitoring the State of Stress in the uppermost crust by measuring geogenic electromagnetic radiation

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Any rock experiencing brittle deformation (large scale to microscopic scale) will emit orientated electromagnetic waves parallel to the maximum active stress. Measuring the electromagnetic wave directions at the earth surface allows to educe the orientation of the acting stresses in the uppermost crust. The radiation is generated by electric dipoles and propagates perpendicular to the vector of the dipole. The wave-emitting dipole may be created in different ways but the main source in the uppermost crust is understood to be microcracking. Rocks under stress suffer a continuous cracking on a molecular scale which can lead to the formation of electron deficits in the crystal lattice. The thereby generated electric dipole is perpendicular to the microcrack and thus the emitted electromagnetic wave is parallel to the crack plane. Microcracks in rocks under stress before final failure will align themselves principally parallel to the maximum acting stress (mode I cracks). In this case the orientation of the emitted electromagnetic wave is parallel to the maximum acting stress. This relation can be used to determine stress orientations in the lithosphere by measuring the direction of the electromagnetic waves at the earth surface using a beam antenna. It is a method easy to apply that provides a large database on the orientation of the main acting stresses in the uppermost crust. This allows to compile and/or to refine stress models in the lithosphere on local and regional scale. Comparisons with other stress determinations (e.g. doorstopper measurements, borehole breakouts and geodetic observations of crustal deformation) are in good agreement within the measurement accuracy. The information on the orientation of tectonic stresses in the uppermost crust gained by electromagnetic measurements also correlates very well with modelled stress orientations due to plate motion and plate boundary forces.