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Calculating the Direction of Horizontal Stress from Partially Known Stress Tensors: Application to Seismically Estimated Stress Components

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Earthquakes potentially serve as abundant and cost-effective gauges of tectonic stress provided that reliable means exist of extracting robust stress parameters. Several algorithms have been developed for this task, each of which typically provides information on the orientations of the three principal stresses and a single stress magnitude parameter. A convenient way of displaying tectonic stress results is to map the azimuth of maximum horizontal compressive stress, which is usually approximated using the azimuth of the larger subhorizontal principal stress. This approximation introduces avoidable errors that depend not only on the principal stress axes' plunges but also on the value of the stress magnitude parameter. Here we outline a method of computing the true direction of maximum horizontal compressive stress (SHmax) and show that this computation can be performed using only the four stress parameters obtained in routine focal mechanism stress estimation. Using theoretical examples and new stress inversion results obtained with focal mechanism data from the central Grímsey Lineament, northern Iceland, we show that the SHmax axis may differ by tens of degrees from its commonly adopted proxy. In order to most appropriately compare tectonic stress estimates with other geophysical parameters, such as seismic fast directions or geodetically measured strain rate tensors, or to investigate spatiotemporal variations in stress, we recommend that full use be made of the routinely estimated stress parameters and that a formal axis of maximum horizontal compression be calculated.