

# Pressure-to-depth conversion models for metamorphic rocks: review and application

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Pressure estimated from metamorphic rocks is one of the main tools for geodynamic reconstructions. The pressure-temperature path of UHP metamorphic rocks typically shows a linear increase of P and T followed by a rapid drop of Pressure at near-constant temperature. The geological history can be reconstructed by using the metamorphic pressure as a proxy for depth. Researchers often base their geodynamic reconstruction on a simple linear mapping of pressure to depth, by considering that the pressure is the weight of the overlying column of rock or lithostatic pressure. In recent years, an increasing corpus of evidence demonstrates that rocks can experience pressures that deviate from the lithostatic state on the order of GPa. These deviations can be at the scale of the orogen (Petrelli and Podladchikov, 2002), the outcrop (Jamtveit et al., 2018; Luisier et al., 2019); or even at the grain-scale (Tajcmanova, 2015). Thus, these studies raise the concern that metamorphic pressures may not be reliable proxies for depth, and therefore could not be used for geodynamic reconstructions. The objective of this contribution (1) to review the various models proposed in the literature for metamorphic pressure, (2) to formulate analytical models with simple assumptions that can be used to convert metamorphic pressure to depth even in the case where pressure deviates significantly from the lithostatic pressure. We use our pressure-to-depth conversion models to estimate the depth of ~60 samples from various orogens worldwide. The prediction of the different models varies widely. Some models predict depth as deep as 160km for specific samples, while other models predict depth  $<75$  km (i.e. deepest depth of the Moho) for all data points. We discuss the limits of applicability and the geodynamic implications of each model.

Keywords: metamorphism, overpressure, pressure-to-depth