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Can grain-scale pressure variations provide direct constraints on rheology?

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Recent analytical and theoretical advances imply that petrographic observations should be reconsidered in the light of pressure variations. On one hand, this opens new horizons in metamorphic petrology. On the other hand, it can bring some uncertainties into the currently common assumptions, such as pressure to depth conversion. In fact, if all observations are treated only by conventional methods based on the constant pressure assumption, the interpretations may not represent the appropriate mechanism explaining the microstructure. Considering pressure variations as the other possible interpretation, an alternative model for the development of petrographic observations can be inferred. However, interpreting observed variations in metamorphic grades due as a pressure variation in the same depth are not suitable for pressure-to-depth conversion. Ignoring such pressure variations in petrological analysis can lead to errors in depth estimates that are comparable to the typical thickness of the whole continental crust. Interestingly, microstructures reflecting pressure variations might provide important indications on differential stress and strength variations in a rock. Therefore, here we show how the pressure variation can be used to constrain rheology properties directly from natural microstructures. We document that observations, such as UHP microstructures, would not lose their importance but might play a different role in geodynamic reconstructions.