Cool rocks, but diffucult to handle - Constraints on element transport and thermodynamic equilibria in subduction zones from exhumed high pressure rocks

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Exhumed high and ultra-high pressure ((U)HP) rocks from subduction zones display a unique source of information about the processes that are active during subduction and the associated metamorphic transformation of the subducted slab. They are the only witnesses of processes that are otherwise hidden from direct observation, but trigger large scale element cycles in the solid Earth. Thus, exhumed (U)HP rocks are an indispensable source of information that complement indirect geophysical observations. The immense wealth of processes recorded in such (U)HP rocks is owing to the fact that the metamorphic conditions within the subducted plate - and also in the overlying slab-mantle interface – reach temperatures high enough for the activation of element transport mechanisms on the prograde metamorphic path, but sufficiently low temperatures during the exhumation of these rocks aid to preserve compositional and mineralogical phenomena reflecting these prograde processes. The kinetically hindered equilibration of minerals is a blessing and a curse at the same time, as the information extracted from (U)HP phase assemblages might be misinterpreted. In this contribution I will focus on three examples of common (U)HP minerals that display unique information about subduction processes, but that are prone to misinterpretation due to kinetically controlled element incorporation: (1) Garnet is a versatile mineral regarding the preservation of the reaction path of (U)HP rocks. Can we evaluate whether major and trace element patters in that phase record mineral equilibria or element transport kinetics? (2) Phengite is one of the most important (U)HP minerals with respect to geochronology, but how can we extract valuable chronological information from it and link this information to the metamorphic history? (3) Pyroxenes are potential recorders for pressure and temperature paths, but how many generations can be preserved in a single grain and how does this work?