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On yoderite: Using calculated phase equilibria to investigate its rarity in the geological record of whiteschists

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A new activity–composition model is presented for green (Mn^{3+}-absent) yoderite for use in the latest internally consistent thermodynamic data set used by THERMOCALC, for calculations primarily in MgO–Al_2O_3–SiO_2–H_2O–O system, where O is a proxy for Fe_2O_3. P–T grids calculated with our model in the MASH and MASHO system feature invariant points and univariant reaction bundles that are consistent with existing experimental results. Using this new model, we have explored the stability of yoderite in whiteschists, a rare type of high-pressure rock that conforms closely to the MASHO system. Using a series of calculated models in which composition varies, it is shown that yoderite stability is a function of bulk-rock SiO_2, MgO and Al_2O_3, where the most important component for stabilizing yoderite is a function of pressure and temperature. The rarity of yoderite in naturally occurring whiteschists is largely related to these compositional factors, with most whiteschists having rock compositions that are too SiO_2-rich and Al_2O_3-poor to allow yoderite formation. However, in addition to compositional factors, the calculated P–T stability field of yoderite occurs over thermal gradients that are generally too high to occur in modern-style subduction zones. As nearly all known whiteschist occurrences are Phanerozoic in age, the near-complete absence of yoderite in late Neoproterozoic–Phanerozoic whiteschists may be at least partially due to modern subduction systems failing to produce the hotter thermal gradients needed to stabilize yoderite. The provision of this new a–x model for green yoderite allows for more rigorous P–T–X investigations of all whiteschists.