Quenchable oxygen rich phase from the deep mantle

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Volatiles such as hydrogen, oxygen, carbon and their simple compounds stored in Earth's interiors play key roles in the elemental cycles of Earth's interiors. We recently discovered a pyrite-type structure FeO_2H_x ($0 \le x \le 1$), which is a potential mantle oxygen and hydrogen reservoir mineral. The formation, dehydrogenation and decomposition of this phase act as an important part in the volatile cycling in Earth's deep interiors. Here, we further constrain the stability field of the pyrite-type phase and explore its transformation under high pressure and temperature condition. It decomposes to a new phase by depleting a portion of its oxygen and hydrogen, while it still retains more oxygen than hematite. This phase features higher thermal stability and is quenchable to ambient pressure. Our findings indicate the lower mantle can store a variety of oxygen-rich minerals. The mineralogy at the bottom of mantle might be more complicated than we expected.