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**LETTER**

# Discovery of the first natural hydride

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## ABSTRACT

Although hydrogen is the most abundant element in the solar system, the mechanisms of exchange of this element between the deep interior and surface of Earth are still uncertain. Hydrogen has profound effects on properties and processes on microscopic-to-global scales. Here we report the discovery of the first hydride ($VH_2$) ever reported in nature. This phase has been found in the ejecta of Cretaceous pyroclastic volcanoes on Mt Carmel, N. Israel, which include abundant xenoliths containing highly reduced mineral assemblages. These xenoliths were sampled by their host magmas at different stages of their evolution but are not genetically related to them. The xenoliths are interpreted as the products of extended interaction between originally mafic magmas and $CH_4$+$H_2$ fluids, derived from a deeper, metal-saturated mantle. The last stages of melt evolution are recorded by coarse-grained aggregates of hibonite ($CaAl_{12}O_{19}$) + grossite ($CaAl_4O_7$) + V-rich spinels ± spheroidal to dendritic inclusions of metallic vanadium ($V^0$), apparently trapped as immiscible metallic melts. The presence of $V^0$ implies low oxygen fugacities and suggests crystallization of the aggregates in a hydrogen-rich atmosphere. The presence of such reducing conditions in the upper mantle has major implications for the transport of carbon, hydrogen and other volatile species from the deep mantle to the surface.

**Keywords:** Mantle, hydride, H fluids, crystal structure