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Identification of natural hydrogen generation environments in Australia

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Energy industries are becoming increasingly interested in the prospect of natural hydrogen (H_2) as a potential low carbon energy solution. Exploration is increasing globally, with natural H_2 occurrences reported in areas such as Mali, Oman, Albania, and Australia. With this increased interest, there is an urgent need for governments and industry to receive thorough scientific advice on the viability of natural H_2 as an exploitable resource.

Of the many prospective pathways of natural H_2 production, the oxidation of iron-containing minerals through a process known as serpentinisation is considered a major contributor (eq 1).

However, these reactions in sub-surface environments are complex, with variations in temperature, pressure, presence of mineral catalysts, and rock type all having an impact on the production of H_2 and its exploitability.

We are partnering with federal and state government agencies to identify areas across continental Australia that fit the criteria for being a potential H_2 generation environment. We will focus primarily on H_2 production via iron mediated pathways, with a particular interest in those areas where there is co-occurrence of potential mineral catalysts, such as nickel. We will undertake detailed examination of selected drill hole cores in conjunction with further mineralogical and geological characteristics of the sites. Mineral and elemental characterisation will be undertaken using a range of techniques including powder X-Ray Diffraction, Scanning Electron Microscopy combined with associated minerals identification software, and 3-D Mineral Liberation analysis with Micro-X-ray Fluorescence coupled X-ray Computed Microtomography.

It is hoped that, through these examinations, we will gain valuable insight into the mechanistic factors that are critical in determining whether a particular site represents a sustainable H_2 resource. These factors are expected to be crucial in assessing whether the continuing exploration of natural H_2 at sites is warranted and whether natural H_2 at these sites might represent a valuable energy resource.

$$\underset{\text{Olivine}}{Mg_{1.82}Fe_{0.18}SiO_4} + w H_2O \rightarrow 0.5\underset{\text{Serpentine}}{(Mg,Fe^{II},Fe^{III})_5(Si,Fe^{III})_2O_5(OH)_4} + x\underset{\text{Brucite}}{(Mg,Fe)(OH)_2} + y\underset{\text{Magnetite}}{Fe_3O_4} + zH_2 \quad (1)$$