

A Global Characterisation of Hydrogen Plays: Placing Order into Variability

Owen E. Sutcliffe¹

¹Halliburton

Abstract

Naturally generated subsurface hydrogen is now well known and found in a wide range of reservoirs extending from “high” permeability sedimentary deposits to more challenging “low” permeability basement successions. However, when these settings are compared, an anomaly is noted because consistently higher concentrations of hydrogen are preserved in the former whilst the latter represent one of the main sources for this gas.

In the subsurface, hydrogen has a diversity of chemical reactions responsible for its formation and a complexity of short- and long-term natural processes interacting to preserve it. As an individual accumulation, any hydrogen-rich gas commonly represents a heterogeneous mix of other gases influenced by the level of chemical isolation of the system, the influx of additional gases into it and the residence time of that gas in the reservoir. In short, commonalities between different hydrogen occurrences appear limited. Therefore, to better identify prospective areas for hydrogen exploration it is recommended that our growing knowledge of this subsurface gas is systematized and standardized to better understand variability.

Based on a review of up to 400 reported occurrences of elevated hydrogen (>1%) and adopting an approach like the characterisation of petroleum systems, a classification scheme for subsurface hydrogen is proposed. The purpose of this scheme is to flexibly capture and record both the range of generative and reservoir contexts for hydrogen plays along with the nature of the hydrogen systems that contain them. In tandem with this classification, an approach for comparing the qualities of hydrogen systems is recommended along with a system for differentiating the variable quantities of hydrogen within each play. When the qualities of a hydrogen system are assessed, it will be useful to assess or predict: the scale and quality of the generative system; the form, scale and activity of any migratory system and the qualities of the deposit where hydrogen is hosted. Regarding the composition of the hydrogen-rich gases, five main associations are proposed that are differentiated by their hydrogen content with the recognised variability reflecting dilution and/or hydrogen-consumption of this gas overtime.

Even though exploration for subsurface hydrogen is in its infancy, a range of different hydrogen system types are being considered or targeted by companies. As an effort to accelerate the adoption of subsurface hydrogen, it is essential that our knowledge of these systems is formalised with a level of order being placed on the natural variability of these diverse systems.