Hydrogen Systems in Continental Sedimentary Basins

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The occurrence at Bourakebougou in the Taoudeni Basin of Mali shows that hydrogen will 'accumulate' in sedimentary basins on a potentially commercial scale (Prinzhofer et al. 2018). We investigate the essential components of a hydrogen system operating in and around basins with reference to the Taoudeni Basin.

Hydrogen is expected to migrate and accumulate in basin sediments in the same way as gaseous hydrocarbons. However due to the mobility of hydrogen an important function of the basin setting is that the sediments act as a blanket in slowing down the migration of hydrogen from the source to dissipation in the atmosphere. In this regard 'older' more diagenetically-altered basin sediments (Proterozoic-Lower Paleozoic) are likely to be more retentive. However, despite the effectiveness of the seal, retention (preservation) times are expected to be shorter for hydrogen (i.e. on human time-scales). This is important because, unlike for hydrocarbons, the hydrogen source is thereby required to be currently active. This also means that hydrogen resources are potentially replenishable.

For a hydrogen source we focus on serpentinisation, a metamorphic reaction involving the action of water on olivine (or pyroxene) in ultrabasic rocks at optimal temperatures of ~200 to 310^{o}C. The constraints and controls on the reaction in the sub-surface are poorly understood but the basic requirements are heat and a water supply facilitated by an effective plumbing system.

In the basin setting ultrabasic rocks can occur in the basement as intrusive bodies, ophiolites or 'greenstones'. In Mali the Birimian greenstones of the West African Craton are considered a likely source. The importance of the basin setting is that extra-basinal 'source rocks' can achieve the required temperatures by burial under a 'normal' continental basal heat flow regime.

The key to generating significant volumes of hydrogen in the subsurface therefore is for meteoric water to access basement along the basin margin ('topographically-driven system') and/or via fault systems within the basin ('fault-driven system'). Major, neo-tectonically-active fault systems are recognised traversing the Taoudeni Basin highlighting the potential for an extensive hydrogen 'play fairway'.

Prinzhofer, A., Cisse, C. S. T. & Diallo, A. B. 2018. Discovery of a large accumulation of natural hydrogen in Bourakebougou (Mali). Int. Jour. of Hydrogen Energy, 43, pp. 19315-19326.

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