Natural Hydrogen Perspectives in Greece

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As climate change continues to puzzle countries and scientists worldwide, the European Union targets to achieve climate neutrality until 2050, include hydrogen among the key transition fuels. While focus is mostly on green hydrogen, naturally occurring geologic hydrogen has been recently brought in the spot. Natural hydrogen can be generated by a number of processes e.g. serpentinisation, radiolysis, mantle degassing and bacterial activity, and is found in various geological settings. Among these processes, active serpentinisation in ultramafic rocks-peridotites that persists in orogenic belts and ophiolitic complexes is thought to be the main one generating substantial H_2 amounts. A well-known multi-ophiolitic belt is developed along the Balkan peninsula, from Croatia via Albania down to Greece and further to Turkey. The inspiration which initiated the present study, arose from the recently discovered Bulqize chromite mine in Albania degassing large volumes of hydrogen attributed to deep faulted ophiolites. This work will provide an insight into the exploration potential for natural hydrogen in Greece.

Greece has been scarcely explored in relation to geologic H2 occurrence, although the tectonic conditions and rocks favourable to hydrogen generation occur in many areas. Among those, the wider Spercheios area, together with the adjacent Orthrys ophiolites and the Vourinos ophiolite complex, are considered the most promising. We make a review synthesizing structural and geological knowledge using geological archives, recent publications providing hydrogen measurement data from springs and ophiolite rock samples, geochemical data, magnetic and gravitational maps of these areas and our own observations. The investigation was supplemented by spatial data and the development of thematic maps using geoinformatic techniques and GIS tools.

- Spercheios is located in central Greece. Its graben presents a W-E orientation and is dominated by active deep faults (as it is considered a North Anatolian Fault -NAF westward extension) and a transtensional regime which is responsible for its

geothermal occurrences. The adjacent Orthrys mountainous area is dominated by a N-S compressional regime. The Orthrys ophiolites outcrop along a W-E direction, include the well-known Tsagkli chromite mine and are mainly composed of peridotite, serpentinite and chromite.

- The Vourinos ophiolithic complex, is developed along a NNW-SSE oriented belt that extends from Palaiokastro to Elati villages, including the well-known Aetoraches chromite mines and is mainly comprised of peridotite and serpentine presenting a great spatial length of approximately 27km, lateral extension (equals to 3.5km) and thickness (~12km).

Both areas are well known for their strongly alkaline and hyperalkaline springs which in many cases present intense degassing of one or more gases, such as CH_4, CO_2, He and H_2.

This synthetic approach revealed the following:

1. A number of interesting areas, where geologic hydrogen generation could exist in Greece.
2. In Vourinos and Orthrys ophiolites, serpentinization is the most probable process of hydrogen generation.
3. In Spercheios graben, the produced hydrogen could be attributed to more than one generation processes as the geological framework is more complex (e.g. a blend of tectonic, serpentinization and geothermal processes)
4. Methane in both areas probably occurs by H_2 consumption either by biotic or abiotic reactions. Biotic generation is well documented in one of our study areas.
5. Deeper exploration of both areas should be conducted in order to investigate their potential.