Geologic hydrogen exploration in lithosphere

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Natural geologic white hydrogen and helium exploration is booming worldwide with a view to energy security. The combined production of hydrogen, helium and carbon dioxide in the Earth's subsurface lithosphere provides alternative resources which revolutionize the path to a low carbon future decarbonization for global warming mitigation asnd climate change.Geophysical techniques seismix exploration seismology and passive seismic imaging, magnetotelluric, Controlled source electromagnetic CSEM ,Electrical resistivity tomography ERT, Ground Penetrating Radar, Hydrogen detection Fiber optics sensors, etc. are employed for geologic hydrogen exploration in lithosphere sedimentary and non-sedimentary (igneous) geological settings, to better characterize the hydrogen trap system extensive basement structures and integration of gravity, magnetic and seismic data for basement deeper play lithosphere imaging. This technique provides a high level of understanding of basement tectonics and composition which are key prerequisites in the exploration of helium and hydrogen. Deep earth imaging lithosphere by (geo) neutrino for exploration hydrogen and helium,etc Hydrocarbon systems exploration activities need to address the components of potential helium and hydrogen prospects; trap, reservoir, source and seal. Geophysical exploration strategies for exploring naturally occurring green gases ressources, such as helium and hydrogen, are needed to detect and map potential subsurface reservoirs or pathways and improve understanding of the subsurface dynamics. Structural and stratigraphic interpretation seismic volume is interpreted using a combining structural and stratigraphic analysis. Advanced structural gradient attributes are generated from input multi-trace attributes to enhance the fracture images and ultimately extract 3D fault objects.

Theory / Method / Workflow

Natural Hydrogen Exploration seismic imaging lithosphere subsurface imaging- Landstreamer seismic Geo-scan, geo-comb technologies for lithosphere continental crust , marine streamer seismic for oceanic crust ,satellite gravity,passive seismic , NMR logging- borehole geophysics subsurface imaging and exploration natural resources, Hydrogen detection Fiber optics sensors-DAS Distributed acoustics sensor, Fabry–Perot interferometer (FPI) interferometer technology, fiber grating technology, surface plasma resonance (SPR) technology, micro lens technology, evanescent field technology, integrated optical waveguide technology, direct transmission/reflection detection technology, .Exploration for hydrogen some distinct differences from exploration in hydrocarbon,coal,geothermal,etc. The largest difference is that geologic hydrogen is unlikely to be found in traditional oil and gas fields; any geologic hydrogen that is produced in these fields would likely be consumed by reactions with thermally mature organic matter. Therefore, exploration will be required in regions that have largely been neglected for their poor hydrocarbon potential. Another key difference will be the source rock. However, there may be common elements to the hydrogen system that can be carried over from the oil and gas system including the potential geologic traps. Similar subsurface imaging technologies (e.g., seismic, EM-electromagnetic /MT-magnetotelluric, gravimetric, radiometric, fiber optics sensors, etc.) are employed for hydrogen exploration.The rock layering and sharp impedance contrasts in many traditional oil and gas basins are well-understood and well-suited for high-resolution seismic imaging. In contrast, the lithologies where geologic hydrogen may be expected are more likely to be in old, crystalline rocks that, by their nature, complicate seismic survey interpretation. Seismic interpretation may not be as straightforward for a number of reasons, including sharp impedance contrasts in faulted or fractured rocks which produce complex seismic wave scattering; impedance contrasts which hinder acoustic wave propagation, precluding any seismic information at depth; or insufficient contrast which cannot reflect acoustic waves enough to be detected. Exploration for geologic hydrogen resembles what is exercised in geothermal energy development or in the mining industry, both of which are accustomed to resource exploration in harder rock where using alternative subsurface imaging technologies are more commonplace. Hydrogen exploration may even require a unique combination of geologic, geochemical, and geophysical techniques, where a combination of seismic, gravimetric, and magnetic surveys was overlayed with soil sampling data to identify promising hydrogen hotspots.

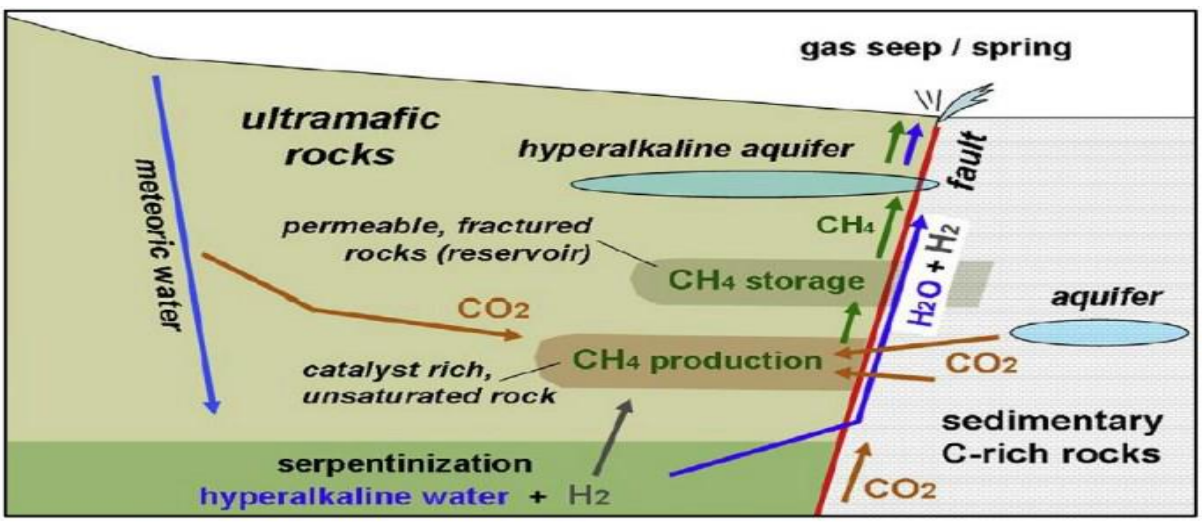

Figure1: Natural geologic hydrogen sources

Results, Observations, Conclusions

Hydrogen is one of the next generation energies in the future. Natural geologic hydrogen reserves explored in USA Brazil, Canada, Australia,Russia Namibia, Mali, etc. Digital twins of multiscale 3D heterogeneous geological objects: 3D simulations and seismic imaging of faults, fractures and caves-Numerical simulation of seismic waves' propagation and imaging in a three-dimensional multiscale geological media is one of the main trends in the development of modern geophysicsThe production of natural hydrogen results from, among other processes, the mineralogical composition of the rock in which the fluids circulate, the degree of alteration of the rock and the geological history of the ophiolite. Fiber optic hydrogen sensors: Effect of hydrogen gas on FBG-based optical fiber sensors for downhole pressure and temperature monitoring , hydrogen subsurface storage leakage monitoring is very dangerous and important because of its low ignition energy, high combustion efficiency, and smallest molecule. Hydrogen and helium exploration - neutrino geoscience takes the advantage of the technologies developed by large volume neutrino experiments and of the achievements of the elementary particle physics in order to study the Earth interior with new probe geoneutrinos.

Acknowledgements

https://www.irena.org/Energy-Transition/Technology/Hydrogen

International Renewable Energy Agency (***IRENA***), Abu-Dhabi,UAE

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https://www.unido.org/hydrogen

International Centre for Hydrogen Energy Technologies ,Austria
https://www.hydrogenenergycenter.org/
The International ***Centre*** for ***Hydrogen*** Energy Technologies (ICHET) TURKEY

UNIDO-ICHET.ORG, https://unece.org/hydrogen

https://www.seforall.org/our-work/initiatives-projects/energy-compacts

References

https://hyterra.com/, https://e2s-uppa.eu, https://www.leap-re.eu/hyafrica/

https://geoscientist.online/sections/unearthed/natural-hydrogen-the-new-frontier/

http://kamland.stanford.edu/GeoNeutrinos/geoNeutrinos.html

https://www.geoneutrino.nl/, EARTH=Earth AntineutRiono TomograpHy

https://www.dunescience.org/, Deep Underground Neutrino Experiment (DUNE),

https://www.ifpenergiesnouvelles.com/brief/natural-hydrogen-continental-environments-question-its-origin-solved

https://hydroma.ca/activities-natural-hydrogen/

https://storegga.earth/,https://www.seafuel.eu/the-project/
https://www.hydrasun.com/, https://hynat.com/en/home/, https://www.h2site.eu/en/ ,
https://hyterra.com/, https://e2s-uppa.eu/en/news/natural-hydrogen-isabelle-moretti.html