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# Exploring for natural hydrogen in peralkaline nepheline-syenite plutons: the Kola peninsula, NW Russia

Camille Dusséaux<sup>\*1</sup>, Vyacheslav Pukha<sup>2</sup>, Olga Goychuk<sup>2</sup>, Andrey Kalashnikov<sup>2</sup>, Jessy Dominique<sup>1</sup>, Loïs Monnier<sup>3</sup>, Stefano Salvi<sup>3</sup>, Frédéric-Victor Donzé<sup>1</sup>, Laurent Truche<sup>1</sup>, Valentin Nivin<sup>2</sup>, Julia Mikhailova<sup>2</sup>

<sup>1</sup> Université Grenoble Alpes, ISTERre, CNRS, F-38058, Grenoble, France

<sup>2</sup> Geological Institute, Kola Science Centre, Russian Academy of Sciences, 184209 Apatity, Russia

<sup>3</sup> Géosciences Environnement Toulouse, University of Toulouse, CNES, CNRS, IRD, UPS, 31400 Toulouse, France

It is well established that serpentinization of ultramafic rocks produces natural hydrogen, a phenomenon extensively investigated at seafloor and continents seepage sites. Much less known is that remarkable amounts of hydrogen are detected in peralkaline plutons (e.g. Ilímaussaq, Greenland; Strange Lake, Canada; Khibiny and Lovozero, Russia). The most spectacular occurrences are the last two - the world's largest agpaitic intrusions - where up to 40 mol % H<sub>2</sub>, along with CH<sub>4</sub> and other gases have been detected in fluid inclusions<sup>1</sup> and found to migrate freely in fractures and mine workings<sup>2</sup>. Previous studies have documented extremely uneven distribution of both occluded and, especially, free gases (mainly CH<sub>4</sub> and H<sub>2</sub>)<sup>2,4,5</sup>. These authors consider that these gases formed abiogenically, either through magmatic processes or during subsolidus hydrothermal alteration. Relatively elevated concentrations of subsurface H<sub>2</sub> are found in loose sediments near lithological boundaries, e.g. in fenitized Archean gneiss surrounding both Paleozoic plutons, at the contact between layered and eudialyte-rich units in Lovozero, and in the Central Arch in Khibiny, where occur large REE and phosphate deposits.

Our team seeks to understand how and when hydrogen and associated gases were produced, their migration pathways and where they are stored in Khibiny-Lovozero. To constrain these processes, our efforts combine geochemical, geophysical, mineralogical and environmental approaches. Thus far, field investigations include: (1) mapping soil gases using multi-gas detectors; (2) collecting different rock samples from outcrops and boreholes; (3) sampling spring water and soils. Complementary laboratory analyses include: (1) detailed petrology of rock samples (SEM-EDS, microprobe); (2) bulk-rock gas chromatography, using mechanical grinding; (3) microthermometry and Raman investigation of fluid and melt inclusions. We also experimentally simulated the hydrothermal alteration of pure eudialyte and rocks containing eudialyte and arfvedsonite (250°C, 2 months) to assess their capacity to produce hydrogen and to discuss H<sub>2</sub>-producing reactions<sup>3</sup>.

The study of the origin, migration and storage of natural hydrogen in peralkaline rocks will provide a better understanding of H<sub>2</sub> production during the formation of ore deposits and its role in environmental disturbances. It is also essential for an adequate assessment of natural H<sub>2</sub> as a potential energy resource from continental sources.

**Keywords :** hydrogen, exploration, water-rock interaction; agpaitic; kola; fluid inclusions; melt inclusions

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