# Volcanic chimneys atop granitic basement of the Frøya High (Norwegian Sea): a possible source for natural hydrogen?

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Intrusive volcanic processes of Paleocene to Eocene times from the North Atlantic breakup are well-known in the Vøring and Møre Basins of the Norwegian Sea. This volcanic province is split in two by the Jan Mayen Fracture Zone, which formed during the early stages of sea-floor spreading. A crustal feature with the same NW-SE orientation as the Jan Mayen Fracture Zone extendsbeyond the intrusive zone, all the way to the Norwegian mainland.

Hundreds of kilometers away from the intruded area, where the Jan Mayen fault complex hits the Norwegian coastline, an overall gravity high anomaly, defined as the Frøya High is located just North of the Jan Mayen fault complex. Studies from seismic data and exploration wells reveal that the gravity high anomaly relates to shallow basements rocks, with a very thin to absent Triassic- Jurassic sedimentary cover. The area is quite shallow (top basement at no more than 2s TWT) and characterized by absence of hydrocarbon source rock in the west and with immature source rock (Spekk Fm) towards the east (Spekk Fm. is immature in well 6306/6-1). Exploration wells indicate that the basement is granitic and biotite-rich. Cores from other wells on the Frøya High area also report granitic basement containing Hematites, a ferric mineral known to be the result of biotite oxidation, liberating Hydrogen as a byproduct (Murray et al, 2020).

We have identified a series of intrusive sills within Paleocene sediments of the eastern Frøya High, but also a group of volcanoes and possible lava-flows, draped by late Ypresian sediments. Such an age corresponds to other extrusive volcanic events of the greater Vøring region, towards the end of the North Atlantic breakup. Some of these structures are fully buried in the sedimentary cover, while others remain as relief on the seabed due to extensive erosion from the Mid-Miocene to Pleistocene.

These volcanoes were probably formed when deep, mantellic magma made its way up along the nearby Jan Mayen fault complex and through the Frøya High basement, during the latest stages of the North Atlantic breakup. The heat emitted in the process may have triggered hydrothermal reactions with their accompanying fluids and nearby formations, including, but not limited to the oxidation of ferrous minerals in the Frøya High granites.

Could the hydrothermal oxydation of biotite and other ferrous minerals have actively participated in the creation of a $H_2$ flux ?

**Mots-clés :** Norwegian Sea, Hydrothermalism, Natural Hydrogen, cold basement, intrusive volcanism, extrusive volcanism, Paleocene-Eocene, granite

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