

Water and ethanol reactivity on chalk from water- and gas-saturated zones

D. OKHRIMENKO*, K.N. DALBY,
N. BOVET AND S.L.S. STIPP

Nano-Science Center, Department of Chemistry, University of Copenhagen, Denmark

(*correspondence: denisokr@nano.ku.dk)

Adsorption and wettability properties of chalk in oil-reservoirs are highly affected by many factors. These factors include: the presence of inorganic, polymeric, and especially, organic additives on the surface.

To compare the behavior of samples with different levels of surface coatings, we analyzed the solid surfaces of chalk sampled from a water and a gas zone. We also examined how the adsorbed organic material affects the ability of chalk to interact with polar molecules such as water and ethanol. The changes in adsorption energy of water can be used to predict the changes in surface wettability, while ethanol adsorption studies can help in understanding adsorption mechanisms for polar organic compounds. For investigating porous solids such as chalk, vapour adsorption isotherm determination is an appropriate alternative technique to the methods usually used for adsorption studies.

Isosteric enthalpies of water and ethanol adsorption were examined on chalk samples before and after liquid (chloroform) – solid extraction of the organic matter and compared with the results for synthetic calcite. The chemical composition of the extracted organic fraction was established by chromato-mass-spectrometry and qualitative changes on chalk before and after the extraction procedure were monitored with X-ray photoelectron spectroscopy (XPS).

The XPS spectra show that extraction with chloroform leads to a relative increase in concentration of polar groups on the chalk surface. This is consistent with the extraction experiments, which show that the liquid extract from both chalk samples contains mainly nonpolar long-chain alkanes.

We observed a difference in water and ethanol adsorption behaviour caused by the nature of the solid and the adsorbate. Water adsorption depends on the presence of adsorbed polar groups and enthalpy of adsorption increases with decrease in amount of preadsorbed nonpolar organic matter, while ethanol adsorption is not influenced by amount of polar groups on the chalk surface. At the same time, ethanol bonds specifically to synthetic calcite with an energy of ~200 kJ/mol, which is 3-4 times higher than on chalk. The results can be used in interpreting the adsorption mechanisms for organic matter on natural oil reservoir materials and for modifying surface properties.

Low temperature alteration of serpentinized dunite; A case study from the Leka ophiolite complex

INGEBORG ØKLAND, INGUNN THORSETH,
SHANSHAN HUANG AND ROLF B. PEDERSEN

Centre for Geobiology and Department of Earth Science,
University of Bergen, Allegaten 41, 5007 Bergen, Norway
(Ingeborg.Okland@geo.uib.no)

Ecosystems based on water-rock interactions independent of photosynthesis have been known for the last decades. Systems where processes like serpentinization produce H₂ and simple hydrocarbons supports the hypothesis of a H₂ based subsurface biosphere. Such environments could be important analogues to systems where life originated. The low temperature water-rock interactions in ultramafic rock is poorly constrained. In this study we try to understand ongoing low-temperature reactions through textural, mineralogical and geochemical characterisation of a 50 m long rock core from the dunitic part of the Leka ophiolite complex, mid-Norway, in combination with geochemical analyses of groundwater emanating from this drill hole, and rainwater. Geochemical modelling has been used to describe ongoing processes in this system.

The core show different degrees of alteration from olivine-dominated, near unaltered dunite to nearly completely altered dunite consisting mainly of blocky serpentine with partly open veins lined with fibrous serpentine and brucite. Groundwater infiltration is thought to take mainly place in three major fracture zones in the most altered parts. Analysis of the groundwater show that the pH increases and the Mg and Si decrease as the groundwater evolves. The most evolved groundwater also has elevated levels of H₂ and traces of CH₄.

Since the main part of the water-rock reactions take place in the serpentine dominated part of the rock it is suggested that the H₂ is a result of the reduction? of water due to oxidation of ferrous iron from dissolving serpentine and brucite.