Burial diagenesis of siliciclastic reservoirs and control on formation water chemistry

P. AAGAARD, H. HELLEVANG AND J.S. JAHREN

Dep of Geosciences, Univ. of Oslo, 0316 Oslo, Norway
(*correspondence: aagaard@geo.uio.no)

The general characteristics of the Jurassic clastic reservoirs offshore Norway have been reviewed Bjørlykke *et al.* [1], e.g. the Brent Group sandstones normally have a quartz content between 40-90%, up to 15-20% kaolinite, a variable albite content, and a K-feldspar content decreasing from about 10% at shallow burial to below detection limit at 3.5-4 km depth. Diagenetic phases include frequent carbonate cements, calcite, siderite, ankerite and ferroan calcite. The other burial diagenetic minerals are quartz, albite, illite and minor chlorite, reflecting the original clastic mineral assemblage. Major diagenetic reactions on a mass basis include recrystallization of carbonates, albitization of K-feldspar, later illitization of kaolinites and quartz precipitation. It have been argued by Bjørlykke *et al.* [1] for an overall closed system diagenesis during burial.

We have performed geochemical equilibrium modelling with PHREEQC along an average P, T and P_{CO2} trend in these basins, and compared the results with formation water chemistry for the same formations [2–4]. The closed system hypothesis appears to be reasonable if also some of the kinetic constraints on mineral precipitation are included.

[1] Bjørlykke *et al.* (1992) *Geol. Soc. Spec. Publ.* **61**, 263-287. [2] Egeberg & Aagaard (1989) *Applied Geochemistry* **4**, 131-142. [3] Bjørlykke *et al.* (1995) *Geol Soc. Spec. Publ.* **86**, 33-50. [4] Warren & Smalley (1994) *Geol. Soc. Memoir* **15**.

The impact of large scale contact metamorphism on global climate

I. AARNES[1]*, H. SVENSEN[1], S. POLTEAU[1], J.A.D. CONNOLLY[2] AND Y.Y. PODLADCHIKOV[1]

[1]PGP, University of Oslo, Pb. 1048 Blindern, Norway
(*correspondence: ingria@geo.uio.no)
[2]IMP, ETH Zürich, Switzerland

The formation of Large Igneous Provinces (LIPs) and sill intrusions in volcanic basins, like the Karoo Basin, South Africa, (~183 Ma), and offshore Norway, (~55 Ma) correlate with events of global warming and mass extinctions [1]. A negative shift in $\delta^{13}C$ recorded from these events suggests rapid release of large amounts of isotopically ^{13}C-depleted greenhouse gases to the atmosphere [2, 3]. Such gas releases might be triggered by contact metamorphism of organic-rich shales around magmatic sill intrusions associated with LIPs [4, 5]. In this study we use numerical models of the metamorphic devolatilization to constrain the amount, rate and duration of gas formation around sill intrusions as a function of rock type and sill thickness. The resultant isotopic gas composition is estimated from data on organic matter from natural aureoles in the Karoo Basin.

For a total organic carbon (TOC) content in an aureole of 5 wt% the amount of CH_4 generated is ~120 kg/m^3, exceeding that of H_2O (40-120 kg/m^3). The TOC loss is highest close to the sill. For 1 wt% TOC CH_4 generation is ~20 kg/m^3. Basin scale extrapolation of our modeling suggests that at least 3500 to 9000 Gt CH_4 was generated through contact metamorphism in the Karoo Basin and conservative estimates for CH_4 generation offshore Norway are 500-2000 Gt. Geological evidence suggests that the gases vented to the atmosphere. We conclude that the amount and composition of methane that can be produced and vented from contact aureoles is of the same order of magnitude as required to explain global carbon isotope excursion and hence global warming.

[1] Wignall (2001) *Earth-Science Reviews* **53**, 1-33. [2] Hesselbo *et al.* (2007) *EPSL* **253**, 455-470. [3] Dickens *et al.* (1995) *Paleocean*. **10**, 965-971 [4] Svensen *et al.* (2004) *Nature* **429**, 542-545. [5] Svensen *et al.* (2007) *EPSL* **256**, 554-566.