Impact potential of hypersaline brines released into the marine environment as part of reservoir pressure management.

Jerry Blackford[1]*, Marius Dewar[1], Tony Espie[2], Sarah Wilford[3], Nicolas Bouffin[3]
[1]Plymouth Marine Laboratory, UK.
[2]BP International Limited.
[3]BP Exploration Operating Company Limited.
*jcb@pml.ac.uk; +44 (0)1752 633462

Pressure management of reservoirs used for carbon dioxide storage is a key component of maintaining cap rock and reservoir integrity of the storage complex. Where storage utilizes saline aquifers, pressure management may potentially require production of reservoir brines and their dispersion in over-lying seawater or re-injection~~-~~to a secondary storage facility. Whilst the characteristics of these brines vary greatly, some may be hypersaline (exceeding 200 PSU), hot (exceeding 50°C), anoxic and / or with elevated levels of heavy metals. In their undiluted form, such brines may have the potential to be detrimental to ecosystems. However, dispersion and dilution in well mixed shelf sea environments act to reduce this impact potential.

In marine systems away from estuaries salinity varies between approximately 33 PSU (in polar regions with ice melt) to 39 PSU (enclosed basins such as the Mediterranean); species tend to be adapted to either brackish or oceanic conditions with only highly specialized communities able to tolerate metahaline (>45 PSU) systems. Marine temperature – varies between -2.0°C (Polar) to 30°C (tropical), although site specific ranges tend to be less than 10°C at the sea bed; above 35°C enzyme function becomes sub-optimal and rapidly declines as temperature increases, however most species are adapted to regional temperature ranges. Severe hypoxia is generally recognized as concentrations of O_2 below 2mg/l with impact thresholds of 6mg/l. Impact is also a function of exposure time and other stressors, with many species able to tolerate infrequent short lived exposures to detrimental conditions.

In this study we use a very high resolution hydrodynamic model system, based on the Unstructured Grid, Finite-Volume Coastal Ocean Model (FVCOM), adapted for sea-surface and seabed hypersaline brine releases, using detailed bathymetry and focusing from kilometers down to 5.0 meters around the discharge locations. The model is forced by realistic tidal, current and wind driven mixing to assess the dispersion of hypersaline brines in the natural environment. We investigate the effects of the temperature, salinity and apply tracers to determine and track the effects of the chemical composition of the reservoir waters, including the elevated levels of heavy metals and anoxic conditions. This provides the ability to~~,~~ quantifyi~~ng~~ impact potential from a range of scenarios and dispersion methods, including a combination of seabed, outcrop and sea-surface discharges, across different seasons with specific mixing characteristics.

In relatively shallow well mixed environments we find that the natural mixing processes, dominated by tidal flow, disperse hypersaline plumes rapidly, minimizing any quantifiable impact footprints to scales of 10's of meters in any direction, depending on disposal rate. The models suggest that the mode of disposal, for example at the sea floor or the sea surface will affect impact footprint. This study will allow future cost-benefit appraisal of brine disposal methodologies.