Taking control of subsurface behavior with Smart Gels – an oil & gas exploitation perspective

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The safe, environmentally friendly and cost efficient exploitation of oil and gas resources is becoming increasingly complex. For example, deepwater subsalt developments require fewer wells that must produce reliably over longer periods of time to justify the large capital expenditures necessary to develop. Enabling technologies being developed focus on a wide range of applications along the entire value chain used to discover, recover and transport high energy density resources to the consumer. This discussion will focus on smart materials, particularly smart gels applications that appear promising for subsurface behaviour illumination or imaging and CO2 sequestration applications. Smart gel actions that can be triggered to respond to specific subsurface conditions is an extremely attractive option for geomechanical model forecasts calibration. Calibration of theoretical models used to predict rock mechanical behaviour during drilling and through production can use smart gel trigger responses to excite the subsurface in an observable manner. This may lead to improved calibration of time-dependent model predictions that consider near-wellbore osmotic effects (pore pressure & swelling) and to ground truth far-field reservoir mechanical response to pressure depletion. With regard to applications in geological storage of CO2, an important risk to containment loss is through leakage pathways associated with injection wells. The well schematic shown in Figure 1 illustrates potential CO2 leakage pathways. Regaining containment by sealing these leakage pathways may be problematic, particularly for extremely small crack apertures. The design and application of smart gels to restore CO2 containment will be discussed.

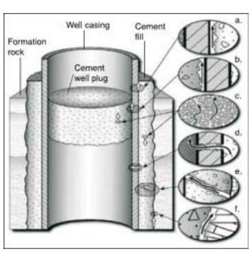

Figure 1: Possible leakage pathways in an abandoned well (modified after Gasda et al., 2004).

[1] Gasda, S. E., S. Bachu, and M. A. Celia (2004), Environ. Geol., 46.

^{54}Cr and Δ^{17}O in carbonaceous chondrites and an old ^{53}Cr/^{53}Mn age of the Paris meteorite

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Mn/Cr isotope systematics in meteorites presents an interesting tool because this isotope system holds double information: the ^{53}Cr-^{53}Mn couple allows us to obtain chronological information while the ^{54}Cr isotope systematics yields information on the mixing of nucleosynthetically distinct components. Although the variations of the ^{54}Cr abundances in meteorites are not yet fully understood, they are nevertheless so systematic that they can be used as a classification tool, very similar to the oxygen isotope systematics.

We present Mn/Cr and oxygen isotope data obtained on recently discovered and/or unclassified carbonaceous meteorites. The oxygen isotopic compositions were determined by laser fluorination on small fragments; the Cr isotopic compositions were measured on sequential dissolution steps of bulk rock powders of all meteorites and on separated mineral fractions of two of them. The mineral separates of Paris, forsterite, fayalite, fine-grained material around chondrules (FGR), fall on a line with a slope of ^{53}Mn/^{55}Mn = 6.183 x10^{-6} and ^{53}Cr$_i$ = -0.165. This slope can be translated into an age based on the LEW Cliff 86010 anchor [1] and corresponds to 4566.33 ± 0.63 x 10^6 y. This old Mn/Cr age shows that the first chondrules formed rapidly (1-2 x10^6 y) after CAIs. The mineral isochron obtained on Tafassasset indicates a younger equilibration age: 4563.31 ± 0.42 x10^6 y.

The ^{54}Cr abundances measured in the bulk rocks of all samples studied as well as the isotopic pattern of the sequential leaching steps allow us to classify Tafassasset as CR, Niger I as CI, Paris as CM and NWA TBC as CV chondrites. Although the existence of a correlation between ^{54}Cr and oxygen in carbonaceous chondrites has recently been questioned [2], our new □Δ^{17}O data for Niger I (Δ^{17}O = -0.361 ±1.189), NWA TBC (- 4.052 ± 0.550) as well as the ^{54}Cr abundances of Tafassasset (^{54}Cr= 1.42± 0.076), Paris (^{54}Cr= 0.925 ±0.098), Niger I (^{54}Cr= 1.64±0.11) and NWA TBC ^{54}Cr= 1.08±0.19) seem to match such a correlation.

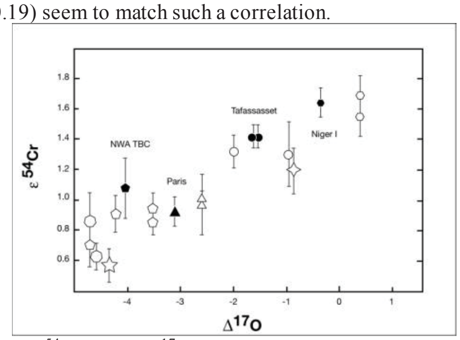

Figure 1: ε^{54}Cr versus Δ^{17}O in carbonaceous chondrites, data from new meteorites are shown as solid symbols. Published data of CC from [3-5]

[1] Yuri (2008) *GCA* **72**, 221-232. [2] Qin (2010) *GCA* **74**, 1122-1145. [3] Trinquier (2008) *AJL* **655,** 1779-1185. [4] Clayton (1999) *GCA* **63**, 2089-2134. [5] Petitat (2011) *AJ* **736**, 23-30.