Laboratory CO_2 flow experiments to model hydrochemical and mineralogical changes in the Arbuckle aquifer during CO_2 storage

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The saline Arbuckle aquifer in south-central Kansas has been proposed for a pilot scale injection of CO_2 [1]. This paper presents characterization of Arbuckle mineralogy and hydrogeochemistry along with experimental flow cell data and geochemical modelling of CO_2 injection. Two wells (KGS 1-32 and 1-28) have been drilled to the basement to provide rock core and brine data for a site specific determination of the storage potential of the Arbuckle. Thin section and XRD data reveal dominant mineralogy in the injection zone to be dolomite with sporadic cherty nodules. Chert appears to replace dolomicrite and euhedral dolomite as well as infilling porosity. Porosity values range between 1.2 and 11.8% within the injection zone. Drill stem test water samples were collected from 8 depths (3677, 4182, 4335, 4520, 4876, 4927, 5036, 5183 ft) to describe the changing brine chemistry with depth. Sulfate peaks at 4876' and 4927' may be indicative of microbial action at these depths. Chemical analysis show a hyper saline brine (~50,000 - 190,000 TDS) dominated by Cl, Na and Ca. Elemental ratios of Cl:Br, Na:Cl and Ca:Sr are what is expected of a typical saline aquifer system [2]. Major and trace elemental chemistry suggest the brine originated from evaporated seawater that has been affected by digenetic processes.

Laboratory flow experiments carried out at the National Energy Technology Laboratory show increases in Ca, Mg, Na and Cl while Fe, S, P and SO_4 decrease within the first 15 hours while hours 15 through 24 show a reverse trend for these elements. Flow experiments at supercritical temperatures and pressures allow determination of the extent of mineral carbonation, mineral dissolution reactions and help constrain reaction rates determined through geochemical modelling [3].

[1] Carr *et al.* (2005) *AAPG Bulletin*. **89** 1607-1627. [2] Barker *et al.* (2011) Abstract, *American Geophysical Union*. [3] Kharaka *et al.* (2006) *J. Geochem. Explor.* **89** 183-183

A textural and mineralogical assessment of NWA 3118

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Northwest Africa (NWA) 3118 is a reduced CV3 chondrite, with large, irregularly shaped Calcium-Aluminum-rich Inclusions (CAIs) and Amoeboid Olivine Aggregates (AOAs) as well as dark inclusions [1]. Previous work by Ivanova [2,3,4] on NWA 3118 showed remarkable features such as compound CAIs with variable degrees of internal melting as well as unusual Zr-Y-Sc-rich mineral inclusion. NWA 3118, a relatively new addition to the list of chondrites, still contains numerous evidences about the early solar system. Initial textural observations were made by optical microscopy. EDS mapping and BSE imaging of uncoated slabs was carried out in variable pressure mode by FEG-SEM. In complement, we investigated the mineralogy of CAIs and AOAs using Raman Spectroscopy.

The surface distribution of chondritic components appears heterogeneous on our slabs where some areas are overpopulated by large inclusions, while other areas are composed of widespread small inclusions, and the rest is a mixture of both. Amorphous (fluffy) CAIs and AOAs are relatively common in NWA 3118 and appear very similar when observed optically. In some cases their shapes are controlled by compression between adjacent chondrules, although there does not seem to be any consistent axis of strain. Silicate chondrules themselves are rarely spherical and some of them appear to have responded to local strain, suggesting that they were partially molten when NWA 3118 was accreted.

Our specimen contains singular assemblages of fine-grained and coarse-grained amorphous CAIs. We also report the presence of compact (spherical) CAIs surrounded by Wark-Lovering rims embedded in fluffy CAIs. The largest compact CAI (400 micron) is associated with two significantly smaller distorted compact CAIs (50 micron) near the edge of its amorphous host.

Because amorphous CAIs and AOAs are nearly indistinguishable in texture, we presume that they were produced by similar physical processes in different reservoirs, or in the same reservoir with an evolving bulk chemistry. The presence of amorphous CAIs with different grain sizes supports the idea that the heat transfer and/or other factors that control crystal size (e.g. degree of undercooling) in the forming region were not uniform. In particular, the presence of compact CAIs included in amorphous CAIs suggests a variable non-uniform heat source where dusty CAI material may have been melted to form compact CAIs which subsequently accreted more dust in a process similar to that suggested for chondrules [5].

[1] Russell et al. (2005) *Meteoritical Bulletin* **89**, *MAPS* **40**, A201-A263. [2] Ivanova et al. (2010) *LPSC* **41**,1670. [3] Ivanova et al. (2011) *LPSC* **42**,1728. [4] Ivanova et al. (2011) *LPSC* **42**,1738. [5] Rubin (2010) *GCA* **74**, 4807–4828.