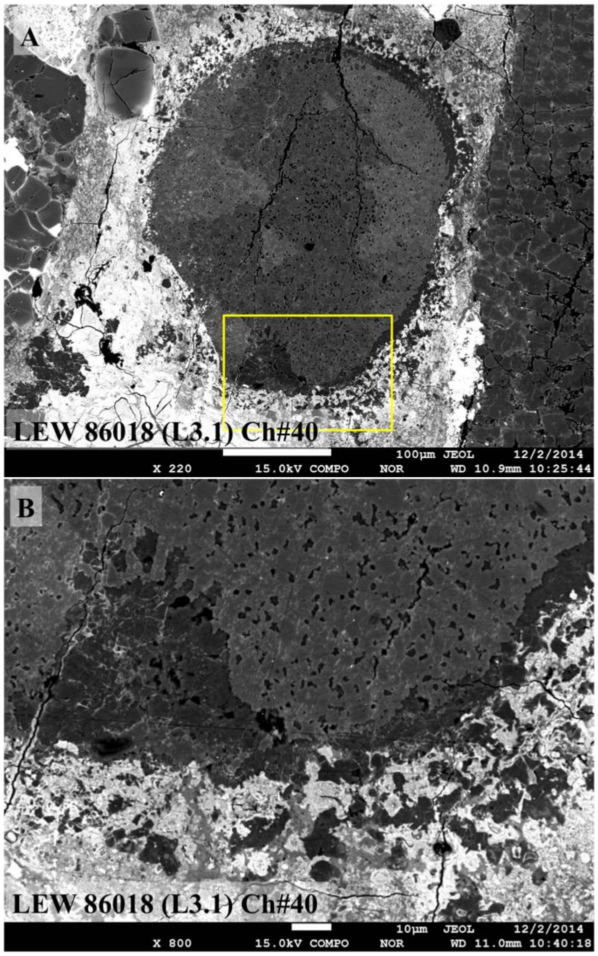
Na, K-RICH RIM AROUND A CHONDRULE IN UNEQUILIBRATED ORDINARY CHONDRITE LEW 86018 (L3.1). R. K. Mishra[1,2], J. I. Simon[2], D. K. Ross[2,3], A. W. Needham[1,2], S. Messenger[2], L. P. Keller[2], J. Han[2,4], K. K. Marhas[5]. [1]Oak Ridge Associated Universities (ritesh.k.mishra@nasa.gov), [2]Center for Isotope Cosmochemistry and Geochronology, ARES division, EISD-XI, NASA-Johnson Space Center, Houston, TX 77058, USA, [3]Jacobs Technology-JETS, 2224 Bay Area Blvd. Houston TX 77058, USA, [4]Lunar and Planetary Institute, Houston, TX 77058, USA, [5]Physical Research Laboratory, Ahmedabad, India.

Introduction: Ordinary chondrites represent the most abundant early Solar system extra-terrestrial (~85% abundance) material available for laboratory studies and expectedly record the most extensive range of alterations effects from unmetamorphosed chondritic material to the highest temperatures of thermal metamorphism [1]. The least metamorphosed chondrites belonging to petrologic type 3, the so called unequilibrated ordinary chondrites (UOCs), provide insights into alteration that happened during the primeval, earliest stage of Solar system formation. The higher grade petrologic types 4-6 ordinary chondrites on the other hand document up to near textural equilibrium (in type 6) extensive thermal metamorphism consisting of minerals and phases providing evidence of equilibration of heterogeneous mineral composition, solid-state recrystallization.

Despite being the most abundant, the effect of alteration is less explicitly understood in ordinary chondrites (even less in UOCs) compared to other groups (e.g. CV, CO, CR). Additionally, the relationship between metasomatism (also referred as aqueous alteration or fluid-assisted metamorphism) and metamorphism (primarily thermal driven) has not been studied and alterations in the ordinary chondrites have been considered to have occurred in absence of fluids in general [1]. Despite this convential view, UOCs of lowest grades (3.0-3.2) show some evidence of low temperature (~200°C), fluid assisted metamorphism in the form of the presence of phyllosilicates [2,3], ferroan olivine, and magnetites in their matrices and occasionally in chondrules [4-6]. Here, we present petrographic and mineralogical studies of UOC, Lewis Cliff (LEW) 86018 to further our understanding of the extent and relative importance of metasomatism and/or metamorphism in UOCs.

Meteorite Sample and Petrography: LEW 86018 is one of fourteen "L" (low iron content) type belonging to low petrographic type 3.1 and is an antarctic find (~502 grams). It is classified as weathering grade "B" implying mild terrestrial weathering as evidenced by moderate levels of oxidation exhibited as rust halos on metal grains and extensive iron staining within cracks. A thin section of ~49.5 mm^2 was mapped for elemental abundances using the JSC JEOL hyperprobe 8530F (FE-SEM) in EDS mode and mineral compostions were determined using WDS. The thin section has >110 chondrules of different textural (predominant porphyritic, cryptocrystalline, radial, barred, compound), and minerological types similar to several other ordinary chondrites. Several chondrules having fine grained Fe-rich fayalitic rims are unevenly distributed within the section. The chondrules are rather tightly packed with little matrix between them along with several regions of extended fine-grain matrix within the section (Figure 1). The presence of Fe-sulphides, and fayalitic grains in the matrix regions are mostly decoupled from locations comprised predominantly by nepheline, albitic, and sodalite (minor) in matrices. These phasesare generally found surrounding chondrules although a few of these Na, Al-rich phases exist without any proximal association to a chondrule. A unique non-porphyritic chondrule (Ch#40; Fig. 1a-c) present in the section has more than half of its outer periphery consisting of Na, Al-rich predominantly nepheline, albite constituting the rim surrounded rather thinly by fine grained olivine (Fe-poor) grains. Within this chondrule several very small grains (~2-5µm) with globular glassy/quenched texture and similar Na, Al-rich mineral composition are present.

Discussion: Metasomatic effects in UOCs appear to be highly localized and a correlation between petrologic type and degree of metasomatism/ metamorphism is lacking. The extent and effect of aqueous fluid interaction with meteoritic components at low temperature has been documented by evidences of phyllosilicates, ferroan olivine, and magnetite in Semarkona, Bishunpur, and a few other type 3 ordinary chondrites [3-7]. More distinctive, wider scale effects have been noted in chondrules from higher petrologic types (3.4-3.6) of Chainpur (LL3.4), Parnallee (LL3.6), and Tieschitz (H3.6) [3,4]. It has been suggested that the metamorphism of these chondrules took place in the nebular environment prior to parent body accretion as adjoining chondrules are devoid of similar metamorphic effect and mineral phases [4]. The observation of Na, K, Al, and also Cl rich phases around the chondrule in the lower petrographic type (L3.1) LEW 86018 is indicative of variable degree of alteration in a given class and is similar to those seen previously only in higher petrographic type (>3.4). This observation and petrogenesis of these phases has significant implications towards understanding metamorphism, metasomatism in the early Solar system. A greater detailed follow up study of microtextures within the chondrules, and also of the adjoining objects, abundance of trace elements (Ba, REE), and oxygen isotopic studies is underway that will help us understand the formation scenario constraining the possible pathways of metamorphism in the UOCs.



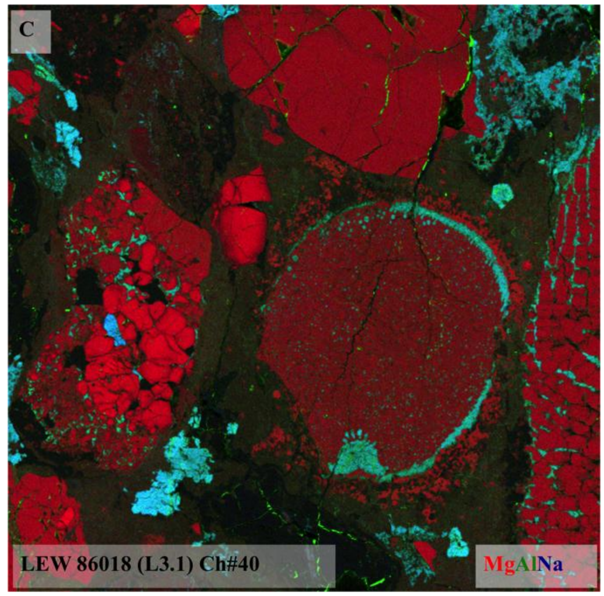


Fig. 1 (a) BSE image of a non-porphyritic chondrule (Ch#40) in LEW 86018 (L3.1) (b) Magnified image of the region of interest shown as inset in A showing evidence of alteration is shown (c) False colour elemental mosaic map (Mg-red, Al-green, Na-blue) of the studied object is shown.

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