EVALUATING POTENTIAL ALTERATION PRODUCTS OF NWA7034: EXPANDING OUR KNOWLEDGE OF MARTIAN CRUSTAL ALTERATION ASSEMBLAGES. S. P. Schwenzer[1], [1]Department of Physical Sciences, CEPSAR, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK; susanne.schwenzer@open.ac.uk.

Introduction: NWA 7034 is a monomict breccia of volcanic [1] or impact [2,3] origin. Interestingly, the oldest zircon ages in the paired NWA7533 meteorite point at an ancient formation age (~4.43 Gyr, [3]), while disturbed younger zircon ages are observed [3], and the Rb/Sr age of NWA7034 is ~2.1 Gyr [1]. According to the initial study by Agee and co-workers [1], NWA7034 shares features with the SNC meteorites and with compositions measured by MER. NWA7034 consists of a variety of clasts [4] some of which show similarities to the Gale Crater rock Jake_M [5]. It is the most oxidized of all SNCs and has the highest water content [1]. Besides high magnetite contents [1], the only potential alteration phase observed to date is terrestrial Ca-carbonate [1]. However, the above mentioned young ages [3] might indicate Martian alteration processes.

NWA7034 potentially is a volcanic [1] or impact breccia [2,3] exposing it to hydrothermal alteration. But because of the potential near-surface nature, NWA7034 might have been exposed to changing surface and subsurface conditions since its formation, thus a complex and multi-stage alteration history of the rock is possible. In addition, it is a terrestrial desert find, which calls for understanding the terrestrial alteration products to be able to disentangle them from potential Martian assemblages. The aim of this study is to investigate potential alteration scenarios of NWA7034 to give insights into Martian volcanic and post-impact hydrous and hydrothermal alteration, and secondary mineral formation during Martian and terrestrial weathering.

Alteration scenarios:

'Pure water' explores the alteration through a dilute fluid, such as meteoric water or ice melt water ('pure water', PW, see also [6] for details), for which an overall dilute water scenario and a CO_2-rich fluid (0.5 mole H_2CO_3) are considered.

Subsurface brine alteration could happen through a brine in equilibrium with underground rocks, such as a pore fluid ('adapted water', AW). In this scenario I use the same fluid used in previous impact-generated hydrothermal and Martian weathering studies [6–9], whereby a CO_2-poor and CO_2-enriched (0.5 mole H_2CO_3) cases are considered.

Acidic fluids: Acid weathering is a widely discussed topic [10], especially late in Martian history. In particular, it has been modeled in the light of the MER findings [11,12]. If the NWA7034 breccia is of volcanic nature, the rock could have been in direct contact with the (hot) acidic volcanic exhalation, too. Because experiments have demonstrated the buffering capabilities of basaltic Martian rocks [13], as much as 0.5 mole of H_2SO_4 were added to PW or AW.

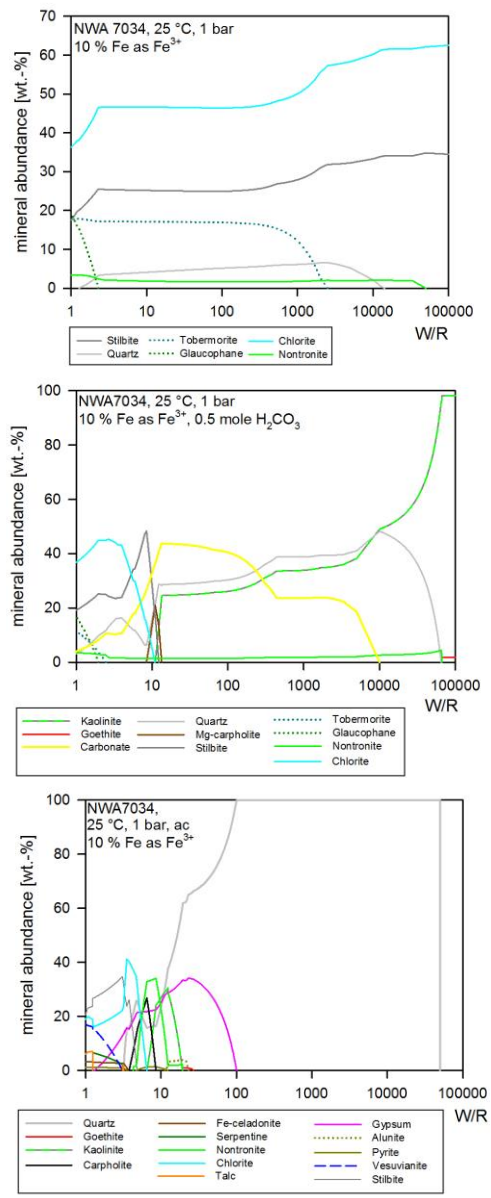

Fig. 1. Results for pure water (PW, top), PW with H_2CO_3 (middle) and PW with H_2SO_4 (bottom) at 25 °C.

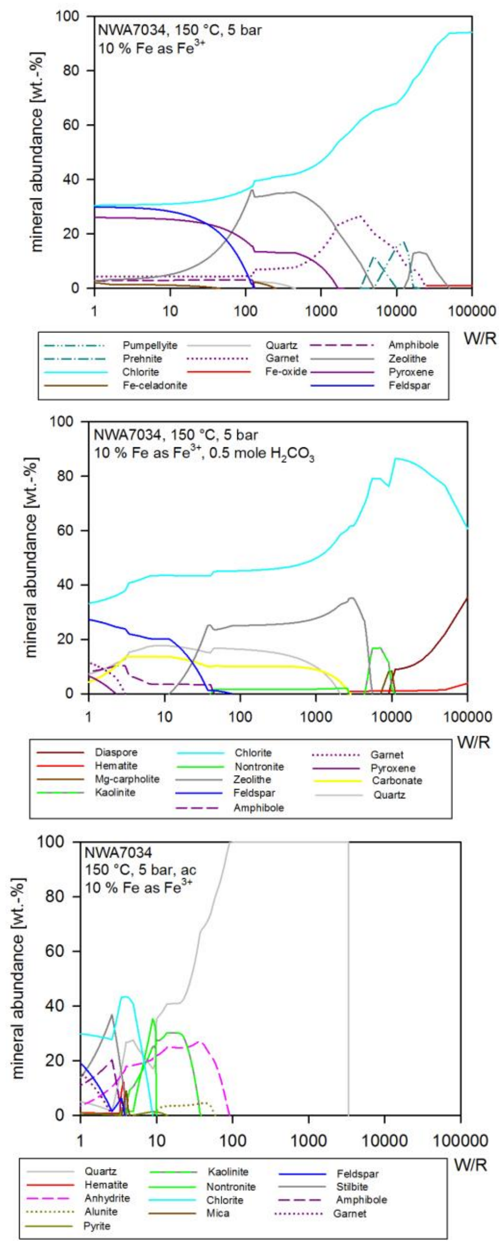

Fig. 2. Results for PW (top), PW with H_2CO_3 (middle) and PW with H_2SO_4 (bottom) at 150 °C.

Method: CHIM-XPT [14] is used with the above starting fluids and NWA7034 host rock composition as given by Agee and co-workers ([1] suppl. p. 24). To account for low-temperature surface (weathering) and subsurface, volcanic or impact-generated hydrothermal alteration, model temperatures are 25 and 150 °C. NWA7034 is described as oxidized, which is taken into account by comparing two host rock oxidation states. 10 and 50 % of total Fe (molar) are taken as Fe_2O_3.

Results: Here I focus on the PW results, i.e., meteoritic water or a fluid from thawing ice (25 °C, Fig. 1; 150 °C, Fig. 2), but will discuss the full data set at the conference and in [15].

In the dilute brine all cations are sourced from the host rock alteration; at W/R 100000 pH is 9.4 (25 °C) and 7.2 (150 °C) and increases with ongoing rock dissolution. The dominating alteration mineral is chlorite, which is accompanied by zeolite. At low T, phyllosilicates occur, whereas at higher T pumpellyite, prehnite, amphibole and pyroxene are formed. In the presence of CO_2, pH is signifcantly lower (4.1 and 4.7, at W/R 100000 for 25 and 150 °C). At 25 °C kaolinite and quartz dominate at high W/R and carbonate (siderite–ankerite–dolomite–magnesite at varying proportions) is the most abundant phase at 500>W/R>10. At low W/R zeolite and chlorite are the two most abundant phases; the carbonate is calcite. At high T, chlorite dominates at all W/R. The acidic case (acidic weathering or fumarolic exhalation) the initial pH is below 1 at W/R 100000 for both T and at W/R of 10 increases to 4.9 and 3.7, respectively. At both T at very high W/R dissolution with no precipitaiton occurs, followed by quartz deposition at high to intermediate W/R. At W/R ~100 gypsum/anhydrite precipitation occurs, accompanied by sulfide. A complex alteration assemblage containing clay minerals occurs at very low W/R.

Conclusions: Depending on alteration conditions, a rock of NWA7034 mineralogy forms a complex set of secondary phases, though chlorite occurs almost independent of T and pH. Kaolinite indicates low-T leaching situations, and quartz (or potentially a hydrous SiO_2-phase) dominates the acidic scenario, in accordance with [16]. Chlorite, nontronite, zeolites and hydrous silica have all been found from orbit in a variety of geologic settings (e.g., [17]) and smectitic clay has been detected most recently by the MSL mission [18].

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