COMPARING DIAGENETIC AQUEOUS ALTERATION PROCESSES OBSERVED AT DIFFERENT MARS LANDING SITES. E. Bonsall[1] , Z. Asimaki[1], and C. Schröder[1], [1]Biological and Environmental Sciences, University of Stirling, Stirling, FK9 4LA, UK, christian.schroeder@stir.ac.uk

Introduction: Reactive iron species are nanoparticulate iron (oxy)hydroxides (npOx). These have been identified on the Martian surface [1,2] with both MER rovers, Opportunity and Spirit, as npOx with the MIMOS II instruments [3,4] and with the MSL rover, Curiosity, as Fe-rich X-ray amorphous material with the CheMin instrument [5]. Reactive iron can form complexes with organic carbon, mutually extending the preservation and preventing transformation [6,7] making them significant for finding evidence of past life on Mars. However, reactive iron is metastable and are transformed during diagenetic processes [7]. Processes that occur prior to erosion and weathering of a sediment after deposition are known as diagenesis (lithification is also classed as a diagenetic process) [8]. Diagenetic processes are visually observed on Mars in the form of nodules, dark raised ridges and veins [8]. These form due to a movement of fluid through the sediment, allowing for ion exchange to occur, thus altering the surrounding sediment chemistry. Fluid movement allows for the removal of soluble ions like Fe^{2+}, Ca^{2+}, K^+, and Na^+, whilst insoluble ions like Al^{3+} remain [9]. Looking at the ratios of the soluble ions to insoluble ions can tell us about the diagenetic processes the sediment has undergone. Good location to look for preserved organic material and potential biosignatures are therefore areas with abundant reactive iron but little evidence for diagenetic processes. Here we tried to identify suitable rock targets from the Spirit, Opportunity, and Curiosity landing sites.

Methods: APXS data from both MER rovers along with the MSL rover were obtained from the publicly available data on the Planetary Data System (PDS).. This was used to compare elemental data of the different rock types observed by the rovers. In this particular case, the data was used to compare the FeO_T/Al_2O_3 ratios from the analyzed rocks. Data were then grouped according to rock classifications at Meridiani Planum [4,10], Gusev crater [3,11] and drill core names at Gale crater [5,12]. Once grouped, the ratio of FeO_T/Al_2O_3 was calculated by dividing the average weight percentage of the FeO_T by the average weight percentage of the Al_2O_3 for each rock grouping. Data from the MIMOS II instrument on both the MER rovers and CheMin data from the MSL rover were also obtained. MIMOS II and CheMin data were used to identify the reactive iron species weight percentages, which is then compared to the FeO_T/Al_2O_3 ratio of the rocks. Some rock types from the MER missions have been omitted due to the MIMOS II instruments ceasing operation during the overall missions. All results were divided by SiO_2 (wt. %) to give relative values.

Results: A graphical comparison of the weight percentage of FeO_T to Al_2O_3 for the different missions is shown in Fig. 1. The average FeO_T/Al_2O_3 ratios of the different rock types is then compared to the average weight percentage of npOx in the rock groups (Fig. 2).

Discussion: Trends in the APXS data are observed and highlighted in Fig. 1 with the arrows labelled **A**, **B** and **C**. These reflect how chemical composition changes with different alteration processes. **A** highlights the loss of Fe in the rock, this is likely due to alteration with a circumneutral fluid, which resulted in the leaching of FeO and the retention of Al_2O_3. **B** reflects the enrichment of FeO with no change in Al_2O_3, which curiously don't occur with results from Spirit. This could be due to the fact that they were unbrushed surfaces [4,10,13]. However other unbrushed surfaces were not as concentrated in FeO. **C** highlights a loss of both FeO and Al_2O_3. For Al^{3+} to be mobilized, a low pH fluid is needed [9], thus reflecting acid weathering of areas of Mars. A general trend is seen in Fig. 2 that samples with high FeO_T/Al_2O_3 ratios, generally have greater amounts of reactive iron than those with low ratios, reinforcing the point that areas of low diagenetic alteration should be targeted for the best chance to find preserved organic compounds and evidence of potential past life on Mars.

Conclusions: The three landing sites show generally similar trends of alteration, but each landing site also has unique trends. Sedimentary rocks at the Curiosity landing sites are best suited for organic compound preservation.

Acknowledgements: We acknowledge an UKRI STFC studentship, grant ref. ST/V50709X/1.

References: [1] Schröder & Bonsall (2021) EPSC2021, 771 [2] Bonsall et al (2022) 53rd LPSC, 2148 [3] Morris R. V. et al. (2006) JGR, 111, E02S13 [4] Morris R. V. et al. (2006) JGR, 111, E12S15 [5] Rampe et al. (2020) Geochemistry, 80, 125605 [6] Lalonde et al (2012) Nature, 483, 198-200 [7] Schröder et al. (2016) Hyperfine Interact. 237, 85 [8] Siebach et al (2014) J. Geophys. Res. Planets, 119, 1597-1613 [9] Hurowitz et al (2006) J. Geophys. Res., 111, E02S19 [10] Mittlefehldt et al (2021) J. Geophys. Res. Planets, 129, e2021JE006915 [11] Morris et al (2008) J. Geophys. Res. Planets, 113, E12S42 [12] O'Connell-Cooper et al (2022) J. Geophys. Res. Planets, 127, e2021JE007177 [13] Berger et al (2020) J. Geophys. Res. Planets, 125, e2020JE006536.

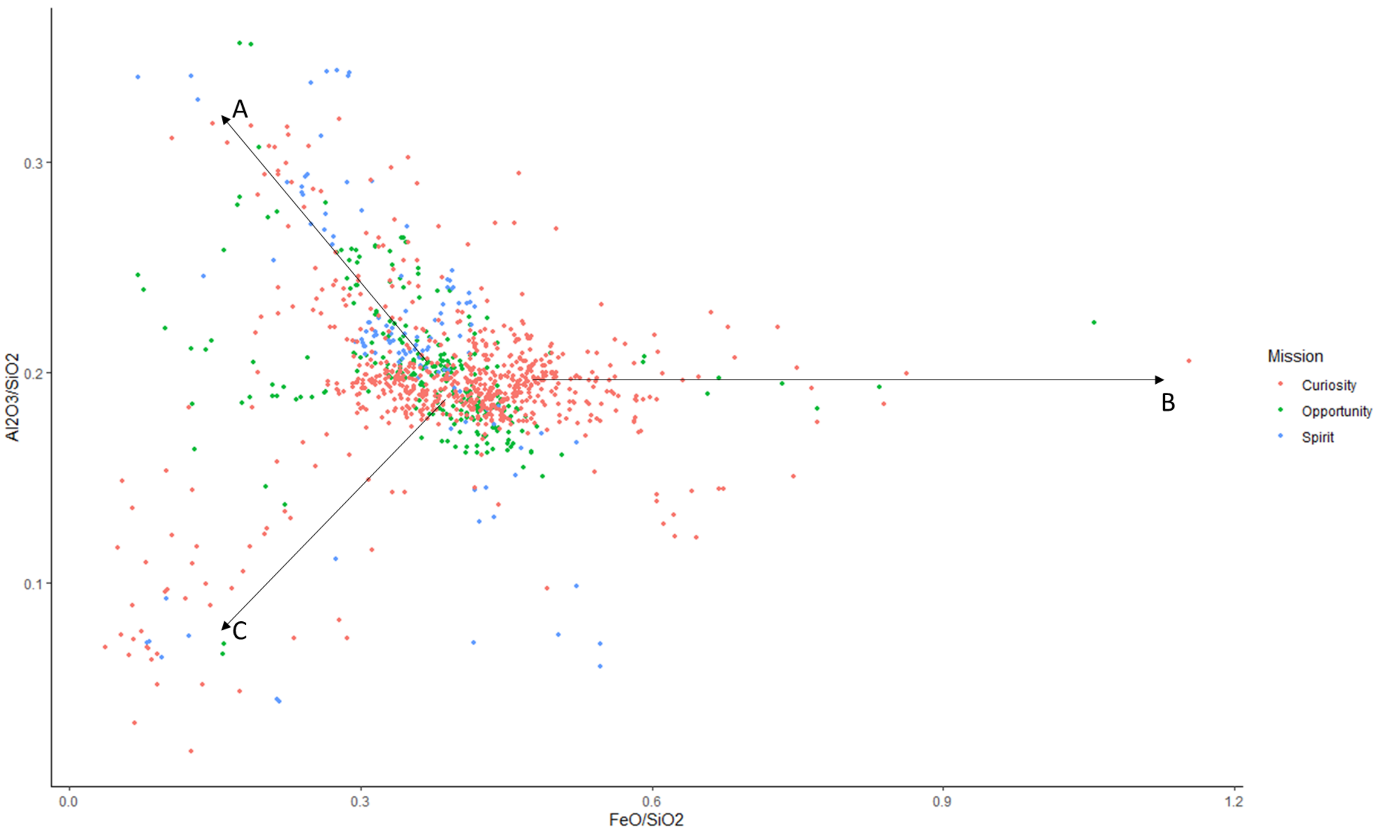

Figure 2. Graph showing FeO_T/SiO_2 against Al_2O_3/SiO_2 wt.% from APXS readings for Curiosity (pink), Opportunity (green) and Spirit (blue). Arrows denote rough trends, A – leaching, B – FeO enrichment, C – acid weathering

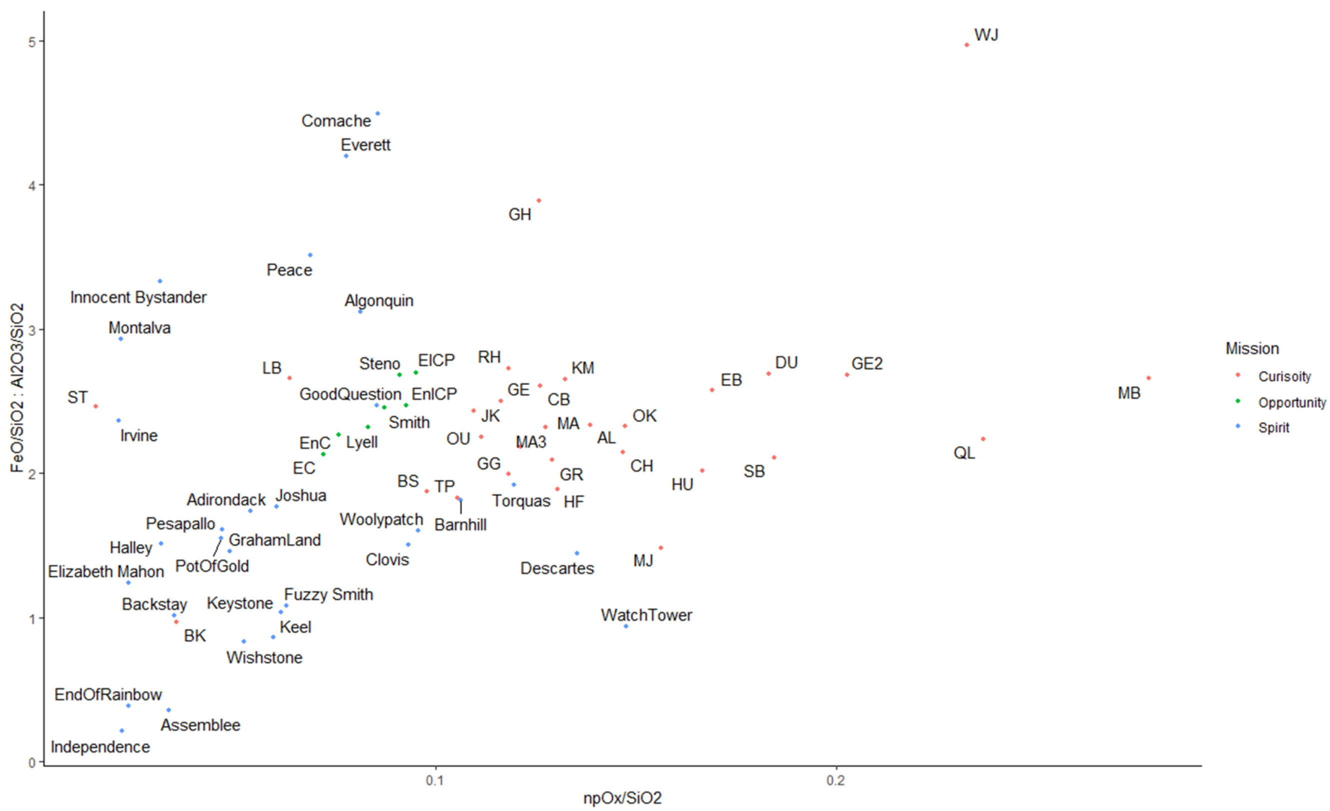

Figure 1. Graph showing reactive iron/SiO_2 against $FeO_T/SiO_2 : Al_2O_3/SiO_2$ for Curiosity (pink), Opportunity (green) and Spirit (blue). Points are labelled with their rock groups/core names [3-5,10-12]