# IN SITU MARS COMPOSITIONS DETERMINED BY ALPHA PARTICLE X-RAY SPECTROMETRY (APXS): OVERVIEW AND COMPARISON WITH MARTIAN METEORITE DATASET.

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**Introduction:** APXS instruments have flown on every rover mission to Mars; the Sojourner Pathfinder rover, both Mars Explorations Rovers (MER) Spirit and Opportunity, and the most recent Mars Science Laboratory (MSL) Curiosity rover providing the opportunity to compare compositional data from different geographic locations on Mars. This work provides an overview of the diverse chemistry encountered, with particular emphasis on the current MSL Curiosity mission results, and the different compositional rock classes encountered along its 13 km traverse. The in situ derived rock and soil compositions will be compared with the martian meteorite data set.

**MSL APXS at Gale Crater:** Curiosity landed on Bradbury Rise within Gale crater, in August 2012, and has since explored an ~13 km traverse en route to the 5 km high Aeolis Mons (Mount Sharp), exposed in the centre of the crater. The instrument payload has been used to investigate rocks and soils, with more detailed analysis performed at locations selected for their distinctive orbital characteristics. The Canadian-built APXS has acquired 291 rock and 27 soil/regolith analyses to sol 1330. Chemical characteristics of the predominantly sedimentary rocks and soils analyzed along the traverse have allowed the APXS team to build a classification scheme highlighting the diversity of rock compositions encountered [1][2] (Fig.1).

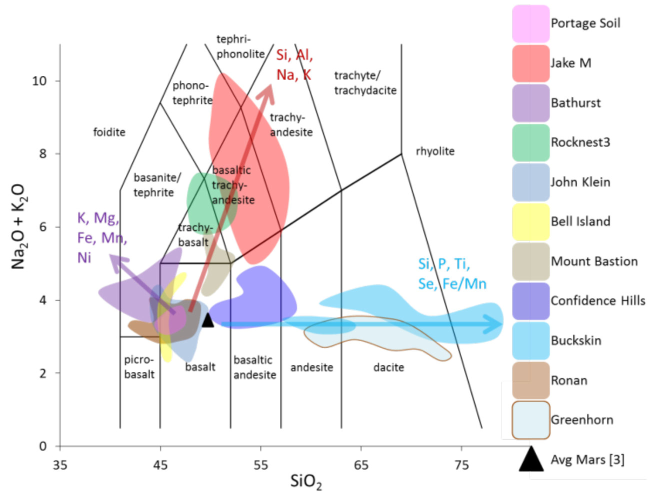


*Fig.1 Total alkalis versus silica plot illustrates the various compositional classes and the major elemental trends exhibited by these classes relative to typical martian basalt.*

**Results:** Many of the sedimentary lithologies are basaltic and are likely to have basaltic protoliths (Fig. 1), supported by XRD CheMin mineralogy results [4]. However, a number of rocks encountered are more alkaline (Fig. 1). Specifically, the alkaline Jake M and potassic Bathurst classes (highest K on Mars) are distinct from rocks analyzed on MER and Pathfinder and from SNC meteorites [5][6][7]. The Jake M targets are interpreted to be predominantly igneous (following terrestrial, alkaline igneous fractionation trends) and the result of fractionation from an alkaline magma at high pressure [7][8]. Some of these rocks may also be sedimentary, but derived from alkaline igneous protoliths. Bathurst class sandstones are probably derived from a source area comprising both potassic trachyte and basaltic igneous rocks [5][6].

High Si content and associated elevated P, Ti, FeO/MnO and Se within the Confidence Hills, Buckskin and Greenhorn sedimentary classes (Fig.1) suggests acid sulfate alteration [9] and/or Si addition during cementation and diagenesis [10]. It may also reflect provenance (particularly for the high Si Buckskin class) [11].

The highest Ni contents so far measured by APXS from in situ rocks on Mars (not meteorites) are from raised nodular features within the Confidence Hills bedrock. The high Ni is associated with elevated Mg and S and interpreted to represent post-depositional precipitation of Mg-Ni sulfates [12].

**Conclusion:** Curiosity APXS has encountered a diversity of rock compositions, many of which are distinct from martian meteorites and rocks encountered on previous landed missions. Variations in provenance for the predominantly sedimentary lithologies, as well as alteration and diagenetic events are invoked to explain the compositions. The multiple provenance source areas suggest a distinct and diverse crustal composition within, and in the vicinity of Gale crater, and have important implications for the igneous history of this region and Mars in general, which likely included potassic, alkaline, basaltic and possibly silicic igneous activity [5][6][7][8][11].

**References:** [1] M. E. Schmidt et al. 2014. Abstract# 1504. 45th Lunar and Planetary Science Conference. [2] L. M. Thompson et al. 2016. Abstract #2709. 47th Lunar and Planetary Science Conference. [3] S. R. Taylor and S. M. McLennan 2009. pp. 378, *Cambridge Univ. Press, Cambridge*. [4] D. T. Vaniman et al. 2014. *Science 343*, 6169. [5] L. M. Thompson et al. 2014. Abstract #1433. 8th International Mars Conference [6] A. H. Treiman et al. 2015. *Journal of Geophysical Research:Planets 121*, 75-106. [7] M. E. Schmidt et al. 2014. *Journal of Geophysical Research:Planets 119*, 64-81. [8] E. M. Stolper et al. 2013. *Science 341*, 6153. [9] A. S. Yen et al. Abstract #1649. 47th Lunar and Planetary Science Conference. [10] J. A. Hurowitz et al. 2016. Abstract #1751. 47th Lunar and Planetary Science Conference. [11] R. V. Morris et al. 2016. Submitted to *Science* [12] L. M. Thompson et al. 2015. Abstract #14294. 6th Lunar and Planetary Science Conference.