AMAZONIAN CHEMICAL WEATHERNG RATE DERIVED FROM STONY METEORITE FINDS AT MERIDIANI PLANUM ON MARS.

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Introduction: The Mars Exploration Rovers Spirit and Opportunity as well as the Curiosity rover have encountered iron meteorites at their respective landing sites on Mars [1-3]. Opportunity at Meridiani Planum also came across several stony meteorite candidates [1,4]. Common meteorite types can be thought of as standard calibration points that allow us to quantify chemical weathering: materials with essentially identical compositions that are being deposited continually onto all surfaces in a wide range of environments, with fall compositions that stay the same over geological timescales. Terrestrial ages can be obtained from cosmogenic radionuclides, and (given that iron in pristine equilibrated OCs or achondrites exists as Fe^0 or Fe^{2+}) the abundance of ferric iron may be taken as a measure of terrestrial alteration [5-7]. This combination of factors provides an empirical means of deriving quantitative weathering in any environment where meteorites are found. If an exposure age can be determined it also applies to Mars. Here we use the Martian stony meteorite candidate finds' ferric iron content and estimates of their exposure age to determine what we believe is the first quantitative chemical weathering rate for Mars.

Stony Meteorite Candidates: Among the many loose rock fragments that Opportunity investigated in detail, four were identified as stony meteorites on the basis of them containing high Ni, metallic iron, and the mineral troilite [1,4]. The chemical composition of all four is most consistent with the HED group of meteorites although they contain more metal and olivine than HEDs generally do. They thus resemble the silicate component of mesosiderites [1,4], which are a group of stony irons. Because of their chemical and mineralogical similarity and because they appear to belong to a rare group of meteorites rather than ordinary chondrites they are most likely paired [4].

Exposure Age: The meteorites' time of fall or their exposure age can be constrained by the crater retention ages of the terrains the meteorites have been found in. The meteorites cluster around Victoria crater, with a larger accumulation of related rocks found at its rim [8]. They may thus be part of the impactor that created Victoria [4,9]. On the basis of the crater retention ages at Meridiani Planum and the gradational state of Victoria [10,11], its formation can be dated at 50 Ma ago, which provides an upper age limit. The meteorites might have fallen after Victoria was created. Erosional features on one of the meteorites suggest a lower age limit of 1-10 Ma. One of the meteorites was found on the rim of Endurance crater, which has an age of 2-4 Ma [11,12]. Other meteorites were found on intercrater terrain, which provides an intermediate age of approximately 20 Ma.

Weathering Rate: Iron mineralogy and oxidation states of the Martian finds have been determined using Opportunity's Mössbauer spectrometer [13]. Applying the age bracket estimate above, this yields a chemical weathering rate of an average of 9±4% Fe^{3+} accumulated over the last 1-50 Ma. Although the Martian finds are not ordinary chondrites, their iron mineralogy is similar to L and LL chondrites. We can thus compare the weathering rate to others determined for L and LL chondrites in terrestrial hot (Sahara, Australia, SW USA) and cold (Antarctica) deserts [5-7]. When the shortes exposure ages is applied (i.e. 1 Ma), the Martian weathering rate approaches the Antarctic rate, arguably the slowest chemical weathering rate on Earth. The Martian rate becomes significantly slower when moving to the longer exposure ages within the age bracket of 1-50 Ma.

Conclusions: We believe that we have determined the first quantitative chemical weathering rate for Mars, which is slower than the slowest rates on Earth. Slow chemical weathering rates on Mars are consistent with slow physical erosion rates estimated over the same time [11]. Similar rates may be determined in other locations on Mars where meteorites can be linked to datable surface features.

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