PLANETARY SCIENCE RESEARCH DISCOVERIES
CosmoSparks

Quick Views of Big Advances

The First Rock Ages Returned from the Surface of Mars

For the first time in the history of space exploration, we have ages of rocks on the surface of Mars thanks to scientists associated with NASA's Mars Science Laboratory mission and data collected by Curiosity rover at Gale crater.

Image PIA17603. NASA/JPL-Caltech/MSSS

Mosaic of Curiosity rover Mastcam images of layered rocks in Gale Crater, including the mudstone that Farley and colleagues studied. From NASA/JPL-Caltech/MSSS. Click for more information and higher-resolution versions.

In a recent *Science* publication Kenneth Farley (California Institute of Technology) and colleagues lay out the framework for their ground-breaking work. In March 2013, Curiosity drilled a number of holes into mudstone at Gale Crater (see image on the right) collecting the powder to perform geochemical analyses, including determining the ages of the rocks. Farley and coauthors used the potassium-argon dating technique, which uses measurements of the amount of argon gas trapped inside the rock. Basically, rocks contain radioactive potassium that, over time, decays into stable argon. This decay occurs at a known rate allowing the scientists to calculate the age of a rock sample once the amount of argon inside is known.

The amazing part of age dating using the instruments on the Curiosity rover is that it has never been done anywhere but on Earth due to the sophisticated equipment required to measure the amount of argon in a rock sample. So, prior to the mission's launch on November 26, 2011 NASA put out a call for new and exciting experiments that could be run simultaneously with Curiosity's prearranged experiments. Farley and his team answered that call by proposing the rover carry equipment similar to what we use to date rocks in Earth-bound laboratories.

The team measured the potassium concentration in the rock powder using the APXS, and then Curiosity's on-board equipment took the rock powder, heated it to temperatures high enough for the argon to escape and then let the mass spectrometer on the SAM instrument do the heavy lifting. The team found that the mudstone has a ***Noachian*** to ***early-Hesperian*** age, 4.21 ± 0.35 billion years old. This result was not completely unexpected. Using crater-counting techniques (based on older

surfaces having more impact craters than younger surfaces) performed long before MSL launched, researchers predicted an age of 3.6–4.1 billion years for the surface. (See image below.)

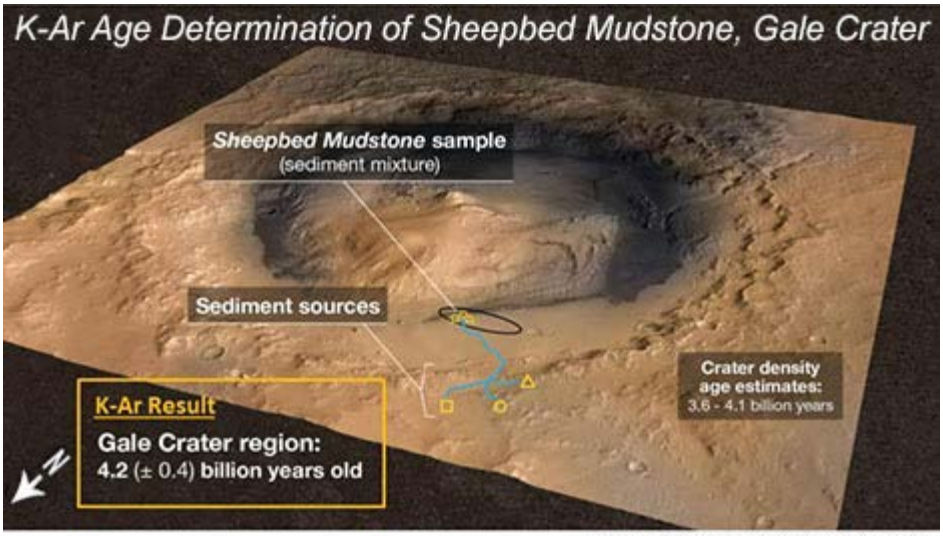

Image PIA17602. NASA/JPL-Caltech

Location of mudstone sample dated by the potassium-argon dating technique onboard the Curiosity rover. This image combines elevation data from the High Resolution Stereo Camera on the European Space Agency's Mars Express orbiter, image data from NASA's Mars Reconnaissance Orbiter Context Camera, and color information from Viking Orbiter imagery. From NASA/JPL-Caltech. Click for more information and higher-resolution versions.

Farley and his team also designed experiments to determine how long various rocks have sat on the surface of Gale crater by measuring the isotopes of helium, neon, and argon produced in the rock because of exposure to ***cosmic rays***. This is a common method used on meteorites and Moon rocks, dubbed surface exposure dating. They found the mudstone at Gale crater has been exposed at the surface (most likely by the erosion of overlying rock layers by windblown sand) for close to 80 million years—a short time in Martian history that may have important implications for finding evidence of possible organic materials on Mars. Cosmic rays disintegrate organic matter at the surface, but at a very slow rate, meaning that the relatively short time these mudstones have been exposed could potentially improve the prospect of finding any preserved organic compounds at a future drill site. Considering this exciting news, we can look forward to more exciting discoveries as Curiosity roams Gale crater.

See Reference:

· Farley, K. A., Malespin, C., Mahaffy, P., Grotzinger, J. P., Vasconcelos, P. M., Milliken, R. E., Malin, M., Edgett, K. S., Pavlov, A. A., Hurowitz, J. A., Grant, J. A., Miller, H. B., Arvidson, R., Beegle, L., Calef, F., Conrad, P. G., Dietrich, W. E., Eigenbrode, J., Gellert, R., Gupta, S., Hamilton, V., Hassler, D. M., Lewis, K. W., McLennan, S. M. Ming, D., Navarro-González, R., Schwenzer, S. P., Steele, A., Stolper, E. M., Sumner, D. Y., Vaniman, D., Vasavada, A., Williford, K., Wimmer-Schweingruber, R. F., and the MSL Science Team (2013) In Situ Radiometric and Exposure Age Dating of the Martian Surface, *Science Express,* December, 2013, doi: 10.1126/science.1247166 [***abstract***].

See also:

· ***NASA Curiosity: First Mars Age Measurement*** Press Release from the Jet Propulsion Laboratory.
· ***Sampling system, including the drill*** described in detail at the MSL Science Corner.
· ***Spectrometers, including APXS and SAM*** on MSL Curiosity Rover.

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