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Analysis of the Mössbauer spectra of Olivine Basalt from Gusev Crater on Mars and Comparison to Terrestrial Olivine Basalt: Implications for the Presence of Magnetic Anomalies on Mars and Erosion Processes.

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The Mars Exploration Rover, Spirit, landed in a 3.9 Ga lava field in Gusev Crater on Mars. Samples interpreted as olivine basalt have been investigated by means of Mössbauer spectroscopy and elemental composition (APXS).

The Mössbauer spectrometer measures simultaneously two types of spectra: originating from backscattered 14.4 keV γ's and from 6.4 keV X-rays, produced in the decay of the Mössbauer state of ^{57}Fe. The main difference between the two types of spectra is in the range below the surface from which they originate. For material of basalt composition, the spectra originate from $\sim$150 μm and $\sim$75 μm depth below the surface for the 14.4 keV and 6.4 keV energies respectively.

The analysis of the Mossbauer spectra has been performed in so-called simultaneous manner, where we make use of the temperature dependence of the hyperfine parameters. This method gives better confidence in the determination of hyperfine parameters and more reliable error estimates.

The two types of spectra show distinct differences related to compositional differences on hundreds of micrometer scale. The difference suggests that the olivine has been oxidized at high temperatures during solidification, a process known to give rise to magnetic anomalies on Earth, and offers a simple explanation for the presence of the magnetic anomalies on Mars. By using the difference observed, we can obtain the "true" interior composition of the rocks and then the rocks show the properties expected for

olivine basalt, such as correlation between magnetite and olivine. Measurements from pristine surfaces suggest that the rocks have dominantly been mechanically eroded.