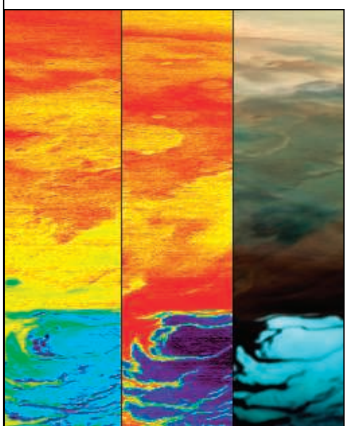
INTRODUCTION

Minerals over Mars

Over the past several years, Mars has been probed with a variety of spacecraft, robotic rovers, and telescopes. Three satellites are now in orbit about the planet, and two rovers are still engaged in exploring its surface. As a result, Mars is starting to reveal many of its secrets, including a more complicated history involving water than many expected (see the Viewpoint by Paige, p. 1575, and the Book Review by Hamilton, p. 1564). Fundamental to an understanding of its history is an accurate geologic map of the surface. This involves identifying specific minerals from space that compose rocks, soil, and ice, and then tying these results to outcrops and landforms, including those that are being analyzed in greater depth by the rovers. Thanks in particular to Mars Global Surveyor and Odyssey, and now Mars Express, this is happening.

Mars Express, operated by the European Space Agency, takes its name from its rapid assembly. It arrived at Mars just over 1 year ago, in December 2003, when it released the ill-fated Beagle II lander. Since then, it has been in a polar orbit about Mars, which provides full coverage of the planet. Mars Express is equipped with a variety of remote-sensing instruments, including several that complement and extend instruments on earlier spacecraft. In this issue, six papers present analyses collected over about 10 months of the chemistry and mineralogy of the martian surface—the prime objective of OMEGA, the visible and infrared spectrometer. The spectrometer covers the range in which many minerals uniquely absorb light, allowing their identification. Mars Express has now identified important minerals in large swaths of the planet, including the poles, at a resolution of about 100 m.



In the first research paper, Bibring *et al*. (p. 1576) highlight some of the key results and provide a global synthesis. OMEGA has mapped the distribution of three important silicate minerals, which delineate primary differences in the martian crust, and several sulfate and water-bearing minerals, which document later alteration involving water. Orthopyroxene, which is a calcium-poor silicate, is abundant in older martian rocks in the high southern hemisphere, but not in younger ones. Sulfates, including most likely gypsum, are common over a large area near the north pole (see the cover) and in layered rocks found by the two Mars rovers over a wide area. Several of these areas also contain hydrated sulfate minerals and abundant absorbed water. Generally, these minerals, indicative of water alteration, are also concentrated, but unevenly, in Mars' oldest rocks. Observations of the north polar cap itself show that large grains of water ice that are relatively free of dust are exposed as the cap wanes and its frost of dry ice sublimates during the summer.

These results, combined with those from other missions, are building up the geologic map of Mars, essentially mineral by mineral, that is needed to decipher its history. More minerals are on the way.

—BROOKS HANSON

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Science

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