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42. The success of this experiment has in a very real sense resulted directly from the individual contributions of several hundred men and women. Among these are the following: G. Bailey, H. T. Enmark, R. F. Lockhart, L. L. Simmons, and F. E. Vescelus (camera engineering); C. C. Avis, G. W. Garneau, P. L. Jepsen, J. J. Lorre, J. A. Mosher, D. J. Royer, A. A. Schwartz, M. J. Sullivan, G. M. Yagi, and the personnel of JPL's Mission Imaging Operations Group (data processing); R. Batson, P. Bridges, J. Inge, C. Isbell, B. K. Luchitta, G. G. Schaber, and R. Tyner (analysis and cartography); J. L. Anderson, R. P. Laeser, A. L. Lane, M. J. Sander, and C. H. Stembridge (project leadership); R. Gurrola, J. T. Harwood, R. Krauss, V. J. Nelson, L. Pieri, F. Popescu, and JPL's Photolab (supporting efforts); and especially M. L. Brownell, C. J. Hansen, P. N. Kupferman, J. L. Mitchell, and the Voyager Sequence Team for their skilled and tireless efforts to coax such magnificent data from a complicated and sometimes reluctant spacecraft. G. E. Hunt is supported by the Science Research Council, Great Britain. This report presents the results of one phase of research carried out at JPL under NASA contract NAS 7-100. We are grateful for careful reviews of the manuscript by M. Malin, D. Muhleman, J. Pearl, and R. Terrile.

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Discovery of Currently Active Extraterrestrial Volcanism

Abstract. *Two volcanic plumes were discovered on an image of Io taken as part of the Voyager optical navigation effort. This is the first evidence of active volcanism on any body in the solar system other than Earth.*

A photograph of Io (Fig. 1) taken by Voyager 1 revealed the first evidence of currently active volcanism on any solar system object other than Earth. This image was taken at 13:28 Greenwich mean time on 8 March 1979 from a range of 4.5×10^6 km. Io was photographed at this time as part of the Voyager optical navigation effort, a program to determine both the ephemerides of the five inner Jovian satellites and the trajectory of the spacecraft through the acquisition and analysis of satellite and star images.

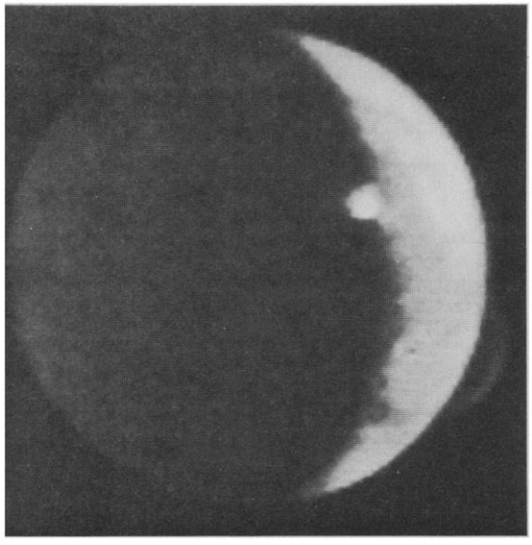

Fig. 1. Narrow-angle image of Io. This 0.96-second exposure was taken through a clear filter by Voyager 1, 3 days after the spacecraft's closest approach to Jupiter. The phase angle is 124°. The image has been digitally enhanced, in contrast and size, to more clearly show the faint cloud above Io's limb. Io's lit crescent is shown as well as its dark hemisphere, which is faintly illuminated by sunlight reflected by Jupiter. Two examples of volcanic plumes are found in this image.

Although not shown in Fig. 1, the original image includes two stars (AGK3-10021 and AGK3-20006). It was the digital processing used to display these faint stars that first revealed a dim cloud (< 10 percent of Io's brightness), which is apparent in the image as a thin crescent above the satellite's eastern limb. It appeared that this crescent might be a second solid body located beyond Io. However, this possibility was ruled out on two bases. First, the diameter of such an object would be sufficient—1000 km or greater—that it should have been previously detected, and second, the spacecraft was about 3° above the orbital plane of the Galilean satellites, so that none of these large bodies could have appeared in line with Io.

A more plausible interpretation of the image is that sunlight is being forward-scattered by a large, well-defined cloud of gas or dust located at least 270 km above the surface of Io. Considering the landforms observed on Io during the closest approach, this cloud is probably of volcanic origin. The cloud is located above, or nearly above, a heart-shaped feature on Io that has been independently identified as a volcanic landform. This feature, at 250° longitude, −30° latitude, can be located on figures 14 and 16 of (*1*), which contains additional examples and a discussion of Io volcanism. Subsequent analysis of this image has revealed that the bright spot at 305°, 10° (just beyond Io's terminator) is a second volcanic plume [see figure 19 in (*1*)] projecting above the dark surface into the sunlight.

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References and Notes

1. B. A. Smith *et al.*, *Science* **204**, 951 (1979).
2. This report presents the results of one phase of research carried out at the Jet Propulsion Laboratory under NASA contract NAS 7-100.

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Infrared Observations of the Jovian System from Voyager 1

Abstract. *The infrared spectroscopy and radiometry investigation has obtained spectra of Jupiter and its satellites between approximately 180 and 2500 cm^{-1} with a spectral resolution of 4.3 cm^{-1}. The Jupiter spectra show clear evidence of H_2, CH_4, C_2H_2, C_2H_6, CH_3D, NH_3, PH_3, H_2O, and GeH_4. A helium concentration of 0.11 ± 0.03 by volume is obtained. Meridional temperature cross sections show considerable structure. At high latitudes, the stratosphere is warmer in the north than in the south. The upper troposphere and lower stratosphere are locally cold over the Great Red Spot. Amalthea is warmer than expected. Considerable thermal structure is observed on Io, including a relatively hot region in the vicinity of a volcanic feature.*

The Voyager infrared spectroscopy and radiometry investigation uses a Michelson interferometer operating in the infrared and a single-channel radiometer sensitive to visible radiation, both of which share a 50-cm Cassegrain telescope. This instrument, designated by the acronym IRIS (*1*), performed well during the Jupiter encounter, with more than 50,000 spectra recorded. Because of a small misalignment that developed during cruise between Earth and Jupiter, satisfactory responsivity of the interferometer is limited to the region be-

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