The Detection of Iron Sulfide on Io. J. C. Granahan[1], [1]SAIC, 4501 Daly Dr., Suite 400, Chantilly, VA 20151 (james.c.granahan@saic.com).

Introduction: The NASA Galileo Near Infrared Mapping Spectrometer (NIMS) collected reflectance spectra of the surface of the mountains of the Jovian moon Io during 2000 and 2001. These spectra exhibit an absorption feature near 3.0 microns consistent with absorption features of iron sulfide minerals. The detection of iron sulfide minerals offers evidence of minerals capable of supporting the high elevations of Io's mountains.

Analysis: Io, the inner most Galilean satellite of Jupiter, is smaller than our moon and yet is the most volcanically active body in the solar system [1]. It possesses approximately 130 mountain structures with an average elevation of 6.5 kilometers [2]. Remote sensing analysis of the surface of this moon indicates that it has a surface composition dominated by sulfur and sulfur dioxide [3,4,5,6]. Structural analysis of the mountains and scarps of Io indicate that these materials are unable to support the observed elevations present on this moon [7].

The Near Infrared Mapping Spectrometer is a hyperspectral sensor that has a spectral range of 0.7 - 5.2 micrometers with a resolution of 0.025 micrometers per channel [8]. It is a whisk broom sensor that scans 20 spatial elements of 0.5 milliradians per element for a total of 10 milliradians per scan. The primary goal of the analysis of the high spatial resolution (5-2 km/pixel) NIMS data of Io's mountain regions (Tvashtar, Gishbar, and Tohil Mons) is to search for non-sulfur dioxide materials in the reflectance spectrum. Smythe et al. [9] identified such a component at 3.15 micrometers in 408 channel spectra from global observations of Io by NIMS. This suggested that it would be possible to find other such non-sulfur dioxide components on Io in higher spatial resolution observations with lower spectral resolution, such as the NIMS data sets of Io's mountains. The lower spectral resolution of 12 or 13 channel data during the Galileo Millennium Mission was due primarily to a grating in the NIMS instrument that was unable to rotate into different collection modes.

The NIMS data set was first classified with a set of unsupervised spectral classification routines such as UNCLASS routine [10] and the Isodata routine in Research Systems Inc.'s ENVI software. Classification enabled the analyst to rapidly scan the spectra for non-sulfur dioxide features. The bulk of the spectra could be partitioned into seven classes, which were dominated by a thermal spectral feature, various concentrations of sulfur dioxide, low albedo, and the presence of a 3.0 micrometer absorption feature.

The 3.0 micrometer spectral feature was of particular interest because it did not correspond to sulfur dioxide spectral features and had not been previously described. Band depth maps revealed this characteristic, which led to a comparison of the sulfur dioxide spectral feature (centered at 4.1 micrometers), the 3.0 micrometer feature, and thermally emitting regions. The 3.0 micrometer feature has been detected on the plateaus of Tvashtar Montes, in the Tvashtar caldera, in the massif of Tohil Mons, and around Gish Bar Patera. All of these localities and morphologic features are associated with some of Io's mountains. This spectral signature may be an indicator of the non-sulfur dioxide material that supports the mountains of Io.

A potential identification of the 3.0 micrometer spectral feature required a search of materials in spectral libraries. This feature is different from the previously described non sulfur dioxide feature since the 3.0 absorption location is in the continuum wings of the 3.15 micrometer feature. Water ice also has a feature at 3.0 micrometers. However, the Io mountains NIMS data do not exhibit the other strong water ice absorption features at 1.48 and at 2.0 micrometers. The intent of this search was to find a match with a silicate mineral. Unfortunately, the silicate minerals that had a spectral absorption feature near this range had features at 2.8 and 2.9 micrometers. Such absorptions would occur in the "wings" or in the continuum of the observed 3.0 micrometer feature. A match was found in the sulfide mid-infrared spectral collection of the Jet Propulsion Laboratory Spectral Library [11]. Figure 1 illustrates the matches of the observed 3.0 micrometer spectral absorption feature with that of the library spectrum of pyrite and pyrrohotite (Iron Sulfide) minerals. Minerals such as pyrite and pyrrohotite may have the density and strength to support the mountains of Io.

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Figure 1.
Possible 3.0 Micron Feature Matches