Appendix 1: Io's hot spots

Rosaly M. C. Lopes, Jani Radebaugh, Melissa Meiner, Jason Perry, and Franck Marchis

Detectsions of plumes and hot spots by Galileo, Voyager, HST, and ground-based observations.

Notes and sources
- (N) NICMOS hot spots detected by Goguen et al. (1998).
- (D) Hot spots detected by C. Dumas et al. in 1997 and/or 1998 (pers. commun.).
- Keck are hot spots detected by de Pater et al. (2004) and Marchis et al. (2001) from the Keck telescope using Adaptive Optics.
- (V, G, C) indicate Voyager, Galileo, or Cassini detection. Other ground-based hot spots detected by Spencer et al. (1997a).
- Galileo PPR detections from Spencer et al. (2000) and Rathbun et al. (2004).
- Locations of surface features are approximate center of caldera or feature.

References

Appendix I: Io's hot spots


Table A.1. Active volcanic centers on Io.

<table>
<thead>
<tr>
<th>Volcanic center</th>
<th>Location of candidate surface feature, if known</th>
<th>Detected by Galileo SSI?</th>
<th>Detected by Galileo PPR?</th>
<th>Detected by Voyager IRIS?</th>
<th>Detected from ground or HST NICMOS?</th>
<th>Plume detected?</th>
<th>Surface change detected?</th>
<th>Notes</th>
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<td>Ruwa Patera</td>
<td>0.5N, 2.7W</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>9812A?</td>
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<td>Faint hot spot detected by SSI in several orbits. Detected from Keck (de Pater et al., 2004).</td>
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<td>Nusku Patera</td>
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<td>No</td>
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<td>Keck (12/2001)</td>
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<td>No</td>
<td>Repeated ground-based detections (07/1998 and 12/2001 from Keck, also detected by C. Dumas).</td>
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<td>9S, 27W</td>
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<td>7±5S, 34±3W</td>
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<td>No</td>
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<td>Detected by SSI in several orbits. N. Polar changes seen by SSI, unclear if location consistent with ground-detected hot spot. Error on ground-observed hot spot ~15 degrees.</td>
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<td>Kannekeili N and S</td>
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<td>17.2S, 33.5W</td>
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<td>detections N5,</td>
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<td>Janus Patera</td>
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<td>Detected several times from the ground (including by Keck on 12/2001).</td>
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<td>Detected by NIMS and SSI in several orbits. NIMS C30 data suggests two hot spots. Second at 7±3S, 34±3W</td>
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<td>Hot spot detected by J. Spencer on 98/08/29 (faded by 98/08/31).</td>
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<td>Possible site of outburst detected on 99/08/02 by R. Howell.</td>
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<td>Detected by NIMS in orbit C30, 131, 132.</td>
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<td>Bright red deposits. Detected by SSI and NIMS in several orbits, including NIMS in 121 and 132.</td>
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<td>Detected during several orbits by SSI and NIMS, including by NIMS in 131. Possible site of outburst detected on 99/08/02 by R. Howell. Hot spot detected by NIMS before outburst (C21).</td>
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<td>Detected by NIMS in E11 and 131.</td>
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<td>Detected multiple times from the ground and by NIMS. Plume deposits detected by SSI in 1996/1997.</td>
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<td>31S, 79.8W</td>
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<td>1±4S, 76±4W</td>
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<td>Hi'iaka Patera</td>
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(continued)
### Table A.1. Active volcanic centers on Io (cont.).

<table>
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<tr>
<th>Volcanic center</th>
<th>Location of candidate surface feature, if known</th>
<th>Detected by Galileo SSI?</th>
<th>Detected by Galileo NIMS?</th>
<th>Detected by Voyager PPR?</th>
<th>Detected by Voyager IRIS?</th>
<th>Detected from ground or HST NICMOS?</th>
<th>Plume detected?</th>
<th>Surface change detected?</th>
<th>Notes</th>
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<tr>
<td>Estan Patera</td>
<td>24.6N, 86.2W No</td>
<td>21±2N, 87±2W and 20±1N, 81±1W</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>Detected by NIMS in 131, 132</td>
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<td>(NIMS 131F and 131M)</td>
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<td>Detected by NIMS in 132. Possibly same as Pollaahu hot spot</td>
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<td>19±1S, 87±1W</td>
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<td>Detected by SSJ in one orbit (GS)</td>
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<td>(NIMS 132J)</td>
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<td>Detected by NIMS during several orbits, including 131, 132. Possible site of outburst detected on 99/08/02 by R. Howell. Detected by Keck on 12/2001</td>
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<td>Gish Bar Patera</td>
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<td>(NIMS 131E, Aluna Patera)</td>
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<td>5±4S, 100±4W</td>
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<td>Itzamna</td>
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<td>Name</td>
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<td>Detected by</td>
<td>Activity</td>
<td>Bright Red Deposits</td>
<td>NIMS in Orbits</td>
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<td>Dusurra</td>
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<th>Volcanic center</th>
<th>Location of candidate surface feature, if known</th>
<th>Detected by Galileo SSP?</th>
<th>Detected by Galileo NIMS?</th>
<th>Detected by Voyager PPR?</th>
<th>Detected by Voyager IRIS?</th>
<th>Detected from ground or HST NICMOS?</th>
<th>Plume detected?</th>
<th>Surface change detected?</th>
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<td>Tvashtar Catena (Lava fountain site)</td>
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<td>Detected by NIMS in 125, 127, G29, 131, 132. Detected by SSI in 125 and G7. Lava fountain seen in 125. Possible site of 990930A and of outbursts in 11/13/00 and 12/16/00.</td>
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<tr>
<td>Unnamed (NIMS 131K, in Tvashtar Catena)</td>
<td>60.5N, 120.4W</td>
<td>No</td>
<td>61±1N, 120±1W</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Detected by NIMS in orbit 131 (131K). Small caldera SE of Tvashtar lava fountain site.</td>
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<td>Maui Patera</td>
<td>16.2N, 123.8W</td>
<td>No</td>
<td>16.5±1N, 124±1W</td>
<td>No</td>
<td>Yes-same as Amirani?</td>
<td>No</td>
<td>V</td>
<td>Yes?</td>
<td>Voyager plume site was at the end of Amirani flow. Hot spot detected by NIMS in several orbits prior to 127, 131, and 132, but position uncertain. Small caldera to the north-east of Tvashtar, detected by NIMS in 131.</td>
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<tr>
<td>Unnamed (NIMS 131L, NE Tvashtar Catena)</td>
<td>67N, 125W</td>
<td>No</td>
<td>67±1N, 125±1W</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Small outburst in NE Tvashtar Catena; detected by NIMS in 131.</td>
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<td>Unnamed (NIMS 131H)</td>
<td>11S, 128W</td>
<td>No</td>
<td>11±1S, 127±1W</td>
<td>No</td>
<td>No</td>
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<td>No</td>
<td>No</td>
<td>Bright red deposits. Hot spot detected by NIMS in several orbits, including 131, 132. Detected by NIMS in 127, 131, 132.</td>
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<td>Malik Patera</td>
<td>34S, 129W</td>
<td>No</td>
<td>34±2S, 128±2W</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Large outburst. Hot spot detected by NIMS in 131, 132. Active flow detected by NIMS in 131, 132. Large plume detected by SSI in 131 and 132.</td>
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<td>Location</td>
<td>Coordinates</td>
<td>Detected by NMS</td>
<td>Detected by NIMS</td>
<td>Detected by SSI</td>
<td>Detected by SSI in orbit G7</td>
<td>Detected by NIMS in</td>
<td>Detected by NIMS in</td>
<td>Detected by NIMS in</td>
<td>Detected by NIMS in</td>
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<td>Yaw Patera</td>
<td>9.3N, 132W</td>
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<td>9.5±1N, 132±1W</td>
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<td>25, 133W</td>
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<td>Tien Mu Patera</td>
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<td>12±1N, 134±1W</td>
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<td>15N, 136.4W</td>
<td>Yes</td>
<td>14.5±1N, 136±1W</td>
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<td>No</td>
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<td>Rumensko Patera</td>
<td>14.5N, 139.3W</td>
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<td>15±1N, 139±1W</td>
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<td>19S, 141W</td>
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<td>17±1S, 141±1W</td>
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<td>No</td>
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<td>32N, 147W</td>
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<td>Volcanic center</td>
<td>Location of candidate surface feature, if known</td>
<td>Detected by Galileo SSI?</td>
<td>Detected by Galileo PPR?</td>
<td>Detected by Voyager IRIS?</td>
<td>Detected from ground or HST NICMOS?</td>
<td>Plume detected? (Galileo = G Voyager = V Cassini = C)</td>
<td>Surface change detected?</td>
<td>Notes</td>
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<td>Surya (NIMS 127A)</td>
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<td>Shamash Patera</td>
<td>35S, 152W</td>
<td>No</td>
<td>34±1S, 153±1W 36±1S, 151±1W</td>
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<td>Yes-same as Malik?</td>
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<td>Prometheus Patera (0.5N, 153W)</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>V, G</td>
<td>Yes</td>
<td>Bright red deposits. Volcanic activity along flow. Persistent hot spot detected by NIMS and SSI in several orbits, including 131, 132. Plume moved between Voyager and Galileo.</td>
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<td>10N, 157W</td>
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<td>27±0.5S, 160±0.5W</td>
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<td>Culana Patera</td>
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<td>Yes</td>
<td>18±3S, 163±3W</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>G</td>
<td>Yes</td>
<td>Bright red deposits. Persistent plume and hot spot. Hot spot detected by NIMS in several orbits, including 132, and by SSI in E11.</td>
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<td>Tsui Goab Fluctus (NIMS 127D)</td>
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<td>0.164W</td>
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<td>Unnamed (NIMS 132E)</td>
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<td>68±1S, 166±1W</td>
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<td>No</td>
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<td>Name</td>
<td>Latitude, Longitude</td>
<td>North, South</td>
<td>East, West</td>
<td>North, South</td>
<td>East, West</td>
<td>Detected</td>
<td>Bright Red Deposits</td>
<td>Activity Details</td>
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<td>Michabo Patera</td>
<td>28N, 168.8W</td>
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<td>No, No</td>
<td>Yes, No</td>
<td>No, No</td>
<td>Yes, No</td>
<td>Yes</td>
<td>Detected by NIMS in orbit 131</td>
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<td>(NIMS 131G)</td>
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<td>Bright red deposits. Detected from Keck 12/2001, Persistent hot spot detected by NIMS and SSI in several orbits, including 132</td>
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<td>Zamama</td>
<td>18N, 174W</td>
<td>Yes, No</td>
<td>No, No</td>
<td>Yes, No</td>
<td>No, No</td>
<td>Yes, No</td>
<td>Yes</td>
<td>Detected by NIMS in orbit 131</td>
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<td>Aalde Patera</td>
<td>42S, 175W</td>
<td>No, No</td>
<td>No, No</td>
<td>Yes, No</td>
<td>No, No</td>
<td>Yes, No</td>
<td>Yes</td>
<td>Detected by NIMS in several orbits, including 127</td>
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<td>(NIMS 132D)</td>
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<td>Detected by NIMS and SSI, Prometheus-type plume and lava flow Detected by SSI in E11</td>
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<td>Volund</td>
<td>25N, 184.3W</td>
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<td>Yes, No</td>
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<td>Yes</td>
<td>Detected by SSI in G1 and by NIMS in E14</td>
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<td>Donair Fluctus</td>
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<td>Yes, No</td>
<td>No, No</td>
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<td>Haokah</td>
<td>26.7S, 187W</td>
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<td>Fo Patera</td>
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<td>Sethlaus Patera</td>
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<td>Gabija</td>
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<td>Lei-Kung Fluctus</td>
<td>38N, 204W</td>
<td>Yes, No</td>
<td>Yes (north and south Lei-Kung)</td>
<td>No, No</td>
<td>No, No</td>
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<td>Isum Patera-N&amp;S</td>
<td>28N, 209W</td>
<td>No, Yes</td>
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<td>32.9N, 204.7W,</td>
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|                       | 30.3N, 206.8W       |              |            |              |            |           |                   |                                                                                   | (continued)
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<th>Volcanic center</th>
<th>Location of candidate surface feature, if known</th>
<th>Detected by Galileo SSI?</th>
<th>Detected by Galileo PPR?</th>
<th>Detected by Voyager IRIS?</th>
<th>Detected from ground or HST NICMOS?</th>
<th>Plume detected? (Galileo = G Voyager = V Cassini = C)</th>
<th>Surface change detected?</th>
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<td>Mardak</td>
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<td>0.9S, 217W</td>
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<td>Kurdalagon</td>
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<td>21±3N, 222±3W</td>
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<td>13S, 236W</td>
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<td>11±2S, 234±2W</td>
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Table A.1. Active volcanic centers on Io (cont.).

Bright red deposits. Detected by NIMS and SSI in several orbits, by PPR in I25, I27, I31, I32
Detected by PPR in I25. Possible Lei-Kung source
Detected by NIMS in several orbits including I24. Detected by PPR in I25, I27, I31, I32
Detected by SSI in E11
Detected by NIMS in several orbits, by SSI in G1. Detected by PPR in I25, I27, I31, I32
Red deposits. Detected by NIMS and PPR in several orbits
Hot spot detected by NIMS in E14 and I24. Detected by PPR in I25, I27, I31, I32
Detected by NIMS in I32
Detected by PPR in I25, I27, I31, I32
Hot spot detected by NIMS in E14
Detected by PPR in I25, I27, I31, I32
Detected by Cassini ISS on 01/01/01
Detected by PPR in I27, I31, I32
Detected by PPR in I25, I27, I31, I32
Detected by SSI in G1, by NIMS in I24 and I32, by PPR in I25, I27, I31, I32
Detected by PPR in I25, I27, I31, I32
Detected by NIMS in several orbits, by SSI in E11. Detected by PPR in I27, I31, I32
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<th>Location</th>
<th>Coordinates</th>
<th>Detected by NIMS</th>
<th>Detected by SSI</th>
<th>Detected by PPR</th>
<th>Detected by Voyager</th>
<th>Detected by Keck</th>
<th>Other Observations</th>
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<td>Yes</td>
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Detected by NIMS in 132. Detected by PPR in 125, 127, 131, 132
Detected by SSI in 111
Major eruption in 1997. Plume detected by SSI and HST. Persistent hot spot detected by NIMS since 1996 (G2). Caldera, fissure vent, lava flows identified by SSI
Detected by PPR in 127, 131, 132
Voyager I detection
Large, bright red deposits. Plume detected also by HST. Very persistent hot spot detected by NIMS, SSI, and PPR numerous times
Detected by PPR in 127, 131, 132
Detected by PPR in 127, 131, 132
Detected by NIMS, SSI, and PPR in several orbits
Very low albedo. Detected by PPR in 127, 131, 132
Red deposits. SSI detected hot spot north of patera. Detected by PPR in 125, 127, 131, 132
Detected by NIMS in several orbits, by PPR in 125, 127, 131, 132
Red deposits. Detected numerous times from ground. Detected as a hot spot by PPR in 125, 127, 131, 132

Detected by PPR in 127, 131, 132
Detected by PPR in 127, 131, 132
Detected by PPR in 127, 131, 132
Observed by Keck on 12/2001

(continued)
Table A.1. Active volcanic centers on Io (cont.).

<table>
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<tr>
<th>Volcanic center</th>
<th>Location of candidate surface feature (if known)</th>
<th>Detected by Galileo SSI?</th>
<th>Detected by Galileo PPR?</th>
<th>Detected by Voyager NICMOS?</th>
<th>Plume detected?</th>
<th>Surface change detected?</th>
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<td>Hephaestus Patera</td>
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<td>Lerna Regio</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Numerous ground-based observations, N1</td>
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<td>Red Deposits</td>
<td>Hot Spot Detected</td>
<td>HST Observations</td>
<td>Detected by</td>
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<td>9606G? N4, D, Keck 12/2001</td>
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<td>Red deposits, hot spot detected by SSI in several orbits. Detected by PPR in 127, 131, 132</td>
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<td>N3, D</td>
<td>G</td>
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<td>9606E7, N12, 0102A, Keck 12/2001</td>
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<td>Pele-type plume deposits observed by Voyager 2. Outbursts observed on 02/2001</td>
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<th>Location of candidate surface feature, if known</th>
<th>Detected by Galileo SSI?</th>
<th>Detected by Galileo PPR?</th>
<th>Detected by Voyager IRIS?</th>
<th>Detected from ground or HST NICMOS?</th>
<th>Plume detected?</th>
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<td>9606C?</td>
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<td>NIMS at 39±1N, 69±1W</td>
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<td>Possibly detected by NIMS in 132, very faint</td>
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Notes:
- Tentative identification of ground-observed hot spot
- Surface changes indicate activity
- Faint spot in SSI G8, E15 images
- New plume deposits detected by SSI in orbit C9
- Possibly detected by NIMS in 132, very faint
- Dark pattern. May be same hot spot as above
- Reported at 22±5S, 79±5W by Goguen et al. (1998) as very bright eruption in 1986. Same as I32J?
- Faint spot in SSI eclipse image
- Possibly detected by NIMS in C30, very faint
- Faint spot detected by SSI in E11
- Identification based on SSI data
- Pillan-type plume deposits detected by SSI in C21, I24
- Possibly detected by NIMS in 132, very faint
- Low albedo and bright red materials
- Probably site of hot spots observed by University of Hawaii AO 06/1997
- Faint spot in SSI G8 eclipse image. Possibly same as hot spot detected by C. Dumas on 6/3/98 at 6±3S, 358±3W and by Keck (Keck “R”)
Appendix 2: Ionian mountains identified to date

Elizabeth P. Turtle, Windy L. Jaeger, and Paul M. Schenk

List of the 135 Ionian mountains positively identified to date, documenting locations, heights, geomorphic classification (tectonic or volcanic), and proximity to paterae (compiled by re-examining and attempting to minimize discrepancies between the lists published in Schenk et al., 2001, and Jaeger, 2005). The geographic positions of adjacent paterae are also noted.
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<th>Tectonic/volcanic (T/V)</th>
<th>Number of paterae in contact with mountain</th>
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Note: Values for longitude increase to the west.
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