CQ3: Volcanoes

NASA Decadal Survey HyspIRI Mission

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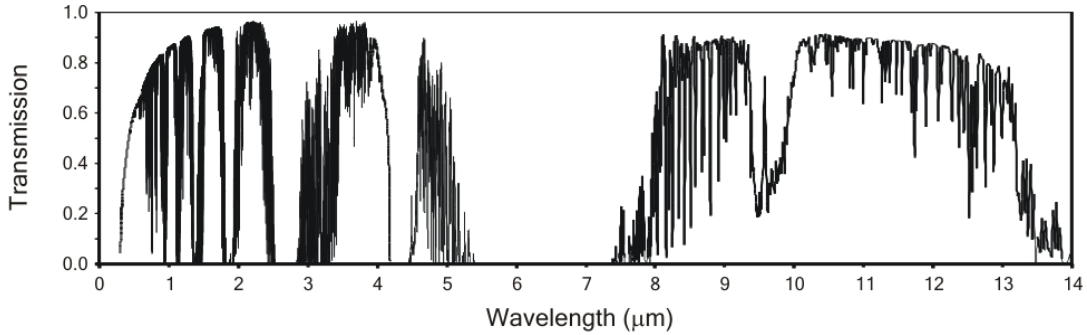
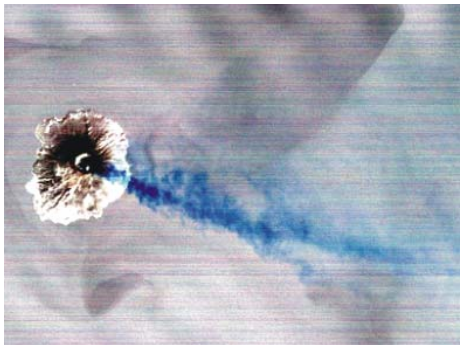
Overarching Question:

Do volcanoes signal impending eruptions through changes in the temperature of the ground, rates of gas and aerosol emission, temperature and composition of crater lakes, or health and extent of vegetation cover?





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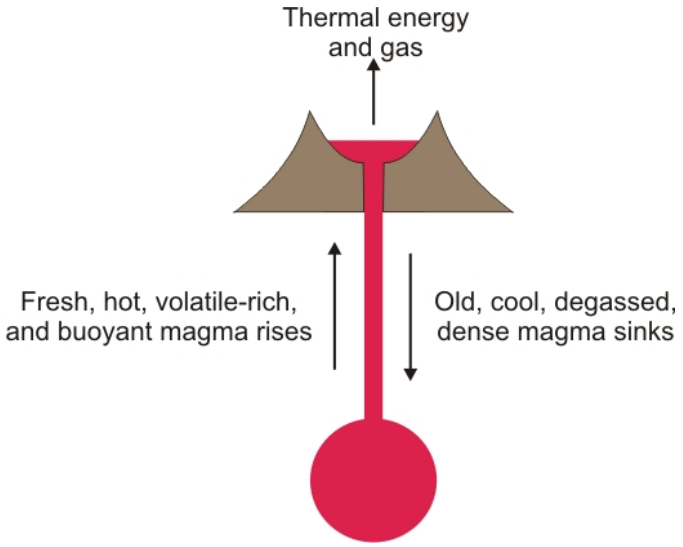
What do comparisons of thermal flux and SO_2 emission rates tell us about the volcanic mass fluxes and the dynamics of magma ascent? (DS 227; 230)

- At some open system volcanoes little lava is erupted. Yet magma must constantly ascend from depth to sustain persistent fluxes of thermal energy and gas. What is the range of mass fluxes at Earth's open system volcanoes? Over what time scales does mass flux vary and by how much? During ascent, how is magma partitioned between the surface (the erupted component) and the subsurface (the intruded component)?

Erta Ale, Ethiopia



Francis et al., 1993, *Nature*

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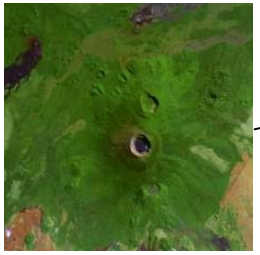
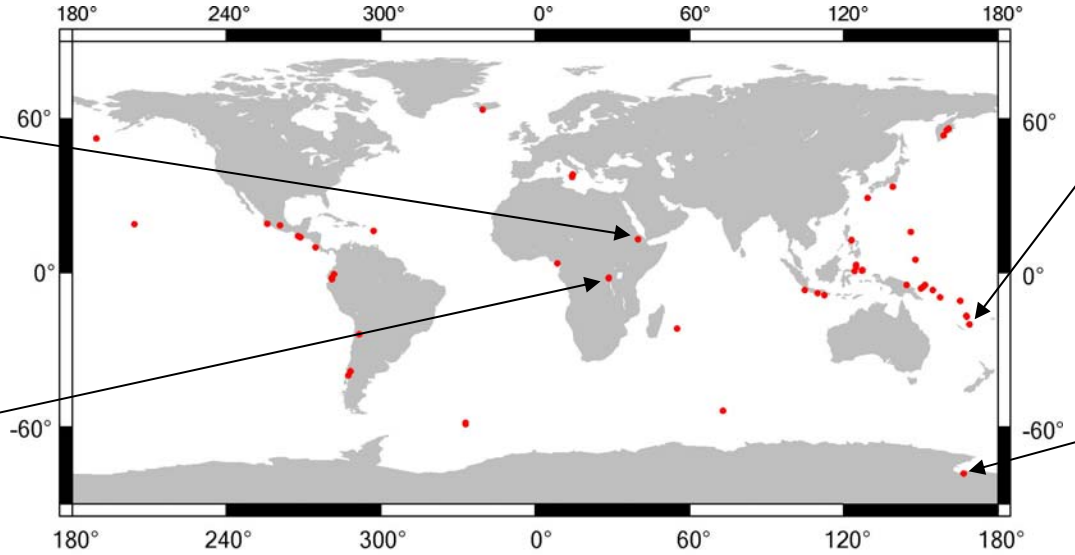
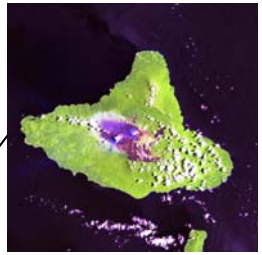
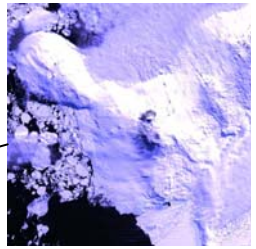
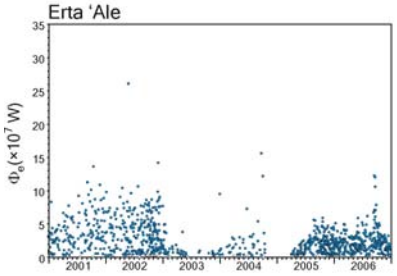
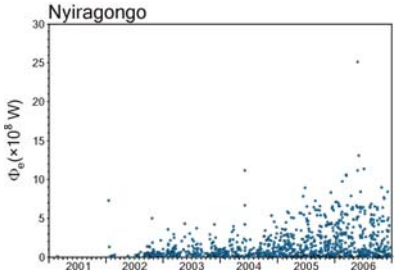




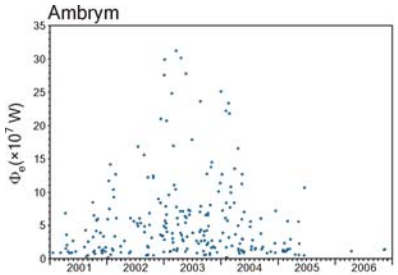


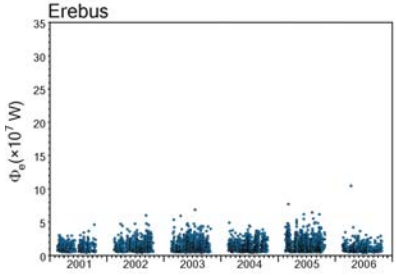






- Significant amount of antecedent data acquired by MODIS-class instruments regarding radiant flux to provide temporal context for HyspIRI measurements
- HyspIRI will provide a high resolution data set from which total heat flux (VSWIR & TIR) *and* gas flux (TIR) can be determined simultaneously, allowing us to quantify volcanic magma budgets





Wright and Pilger, 2008, *J. Volcanol. Geotherm. Res.*

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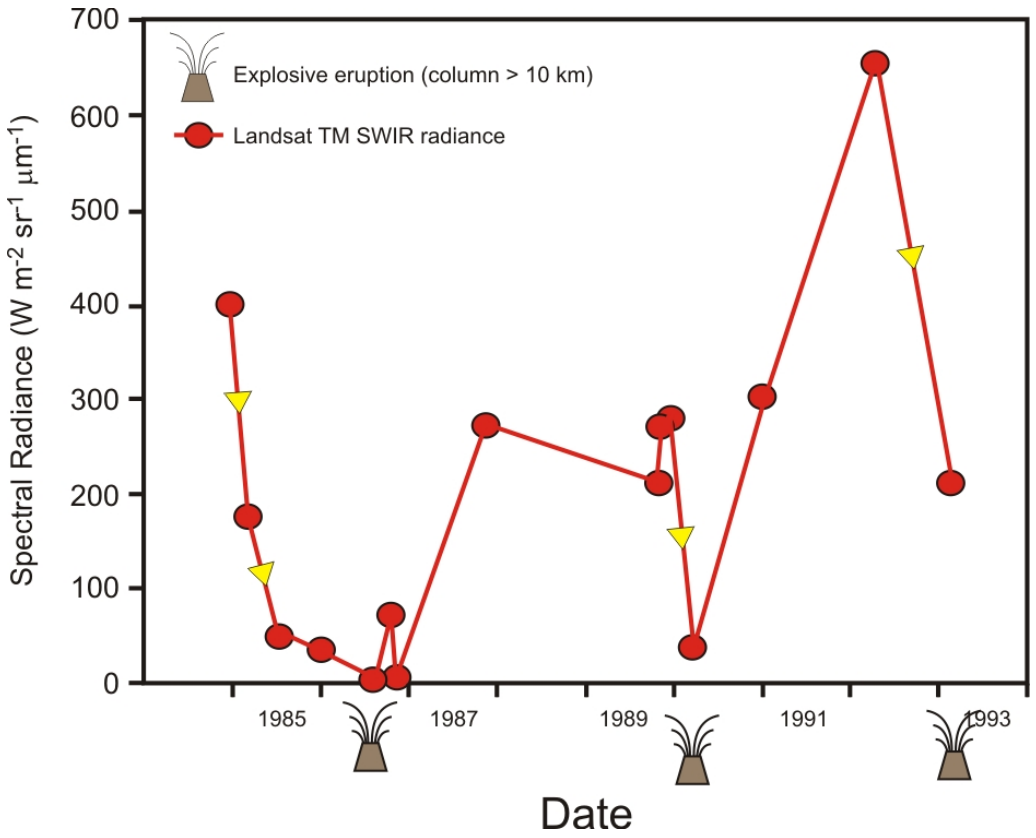
Does pressurization of the shallow conduit produce periodic variations in SO_2 flux and lava dome surface temperature patterns that may act as precursors to explosive eruptions? (DS 50; 227; 230)



- Precipitous drops in SWIR radiance detected by Landsat TM from Lascar's summit crater were followed by significant explosive eruptions
- Cyclicity is increasingly recognized as characteristic of explosive silicic dome-forming volcanoes
- What physical processes control this behavior? Can we use HyspIRI to recognize changes that signify transitions between phases of these cycles

Oppenheimer et al., 1993, *J. Geophys. Res.*

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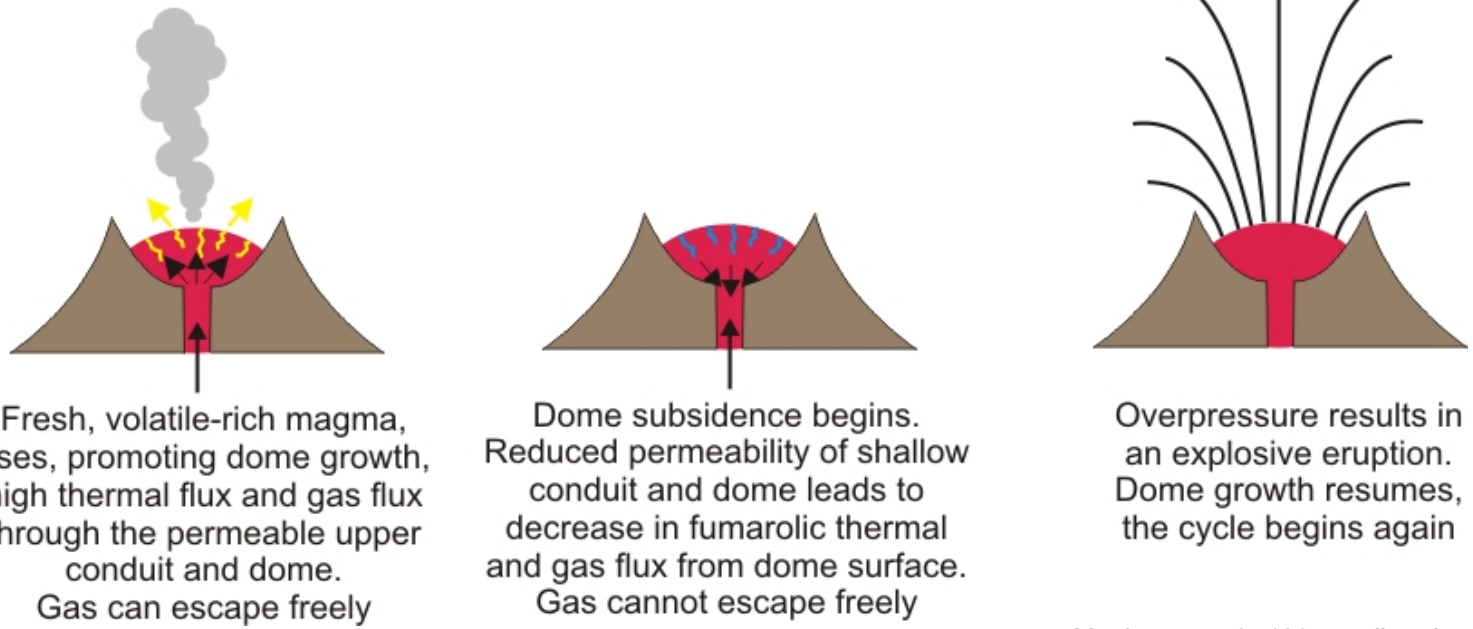

Matthews et al., 1997, *Bull. Volcanol*.

• Unlike previous missions, HyspIRI's VSWIR and TIR instruments will allow us to quantify and monitor temporal variations in gas flux *and* in high temperature fumarolic activity on lava dome surfaces

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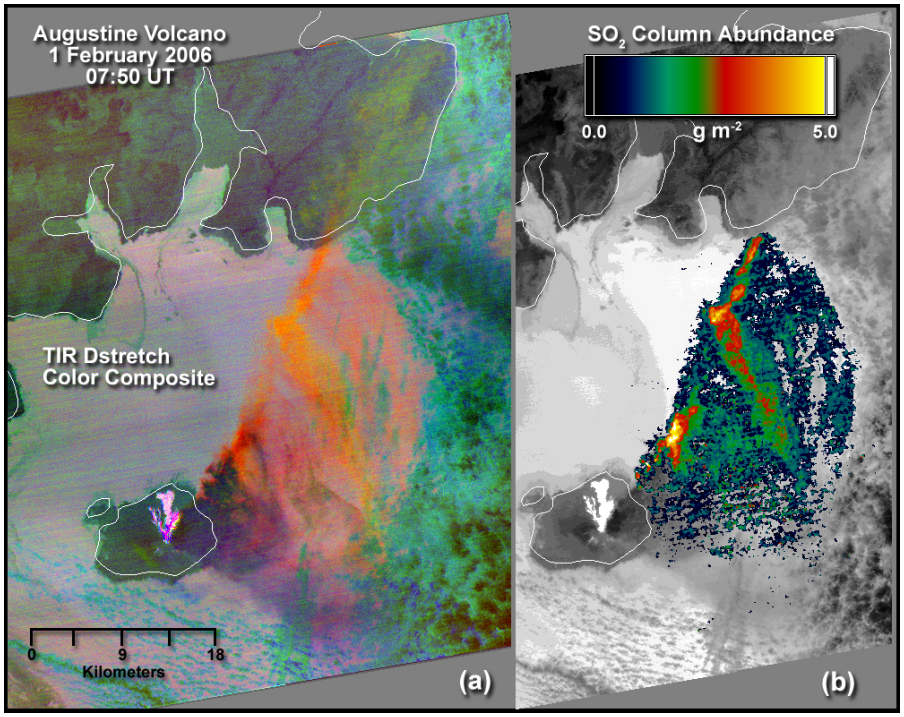
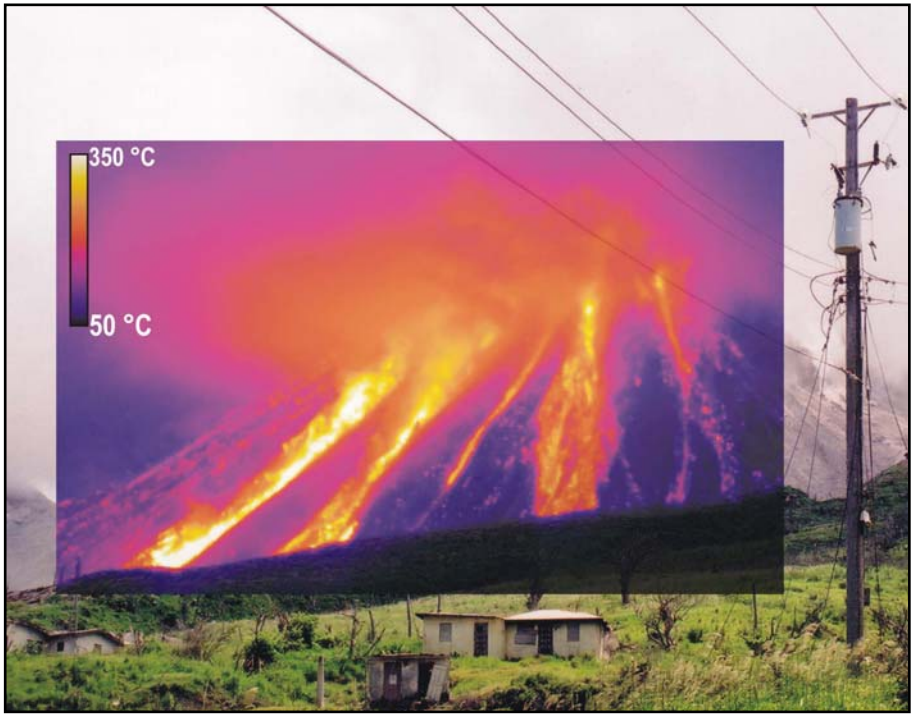
• TIR allows us to quantify and monitor gas flux



ASTER, Augustine, AK

• VSWIR & TIR allow us to quantify and monitor surface temperature characteristics and thermal flux



Soufriere Hills Volcano, Montserrat

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Can measurements of the rate at which lava flows cool allow us to improve forecasts of lava flow hazards? (DS 50; 226)

Mt. Etna, Sicily

- Rate of cooling is required to parameterize numerical models of lava flow motion as temperature controls rheology

- What is the surface temperature of an active lava flow and how does this vary spatially and temporally?

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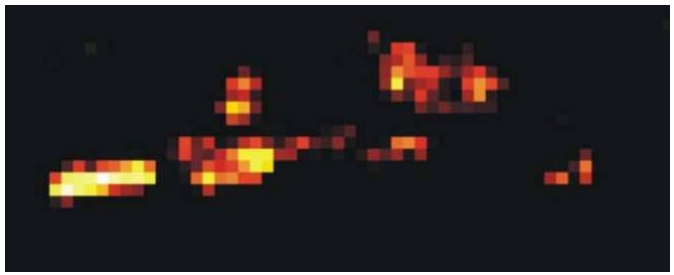
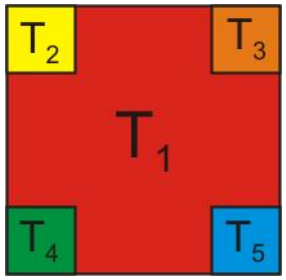
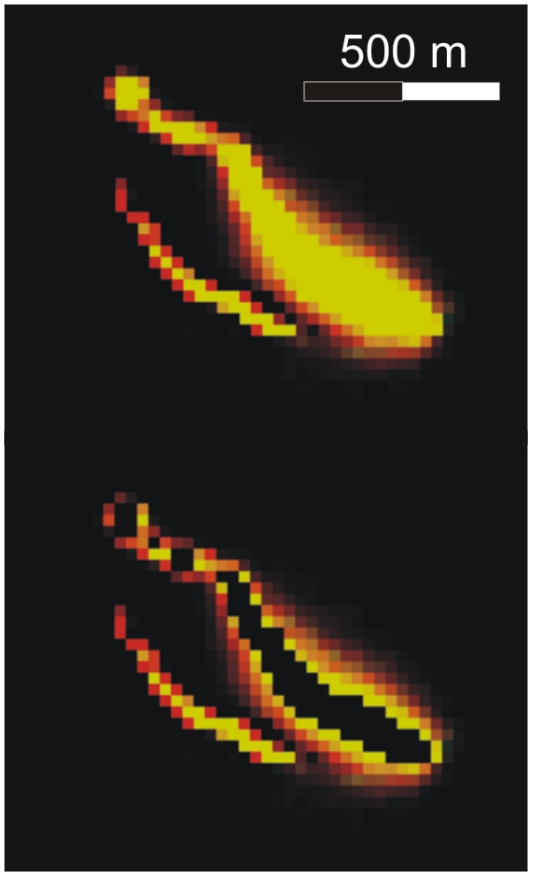




$$L(\lambda) = \sum_{i=1}^{n} f_i L(\lambda, T_i)$$

- A VSWIR imaging spectrometer provides enough wavebands of unsaturated radiance data to perform high temperature un-mixing of lava surface temperatures
- This kind of analysis cannot be conducted using a Landsat or ASTER class instrument due to problems caused by insufficient spectral resolution and sensor saturation



Hyperion, Mt. Etna, Sicily

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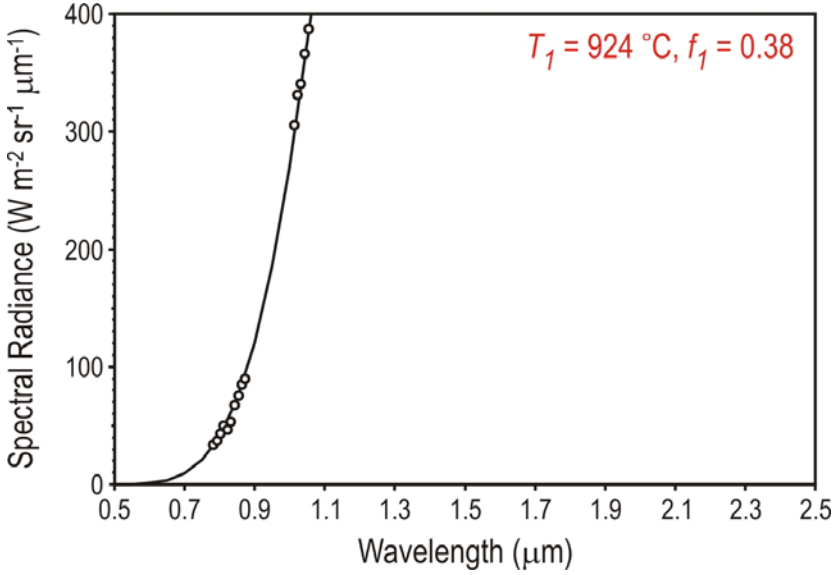

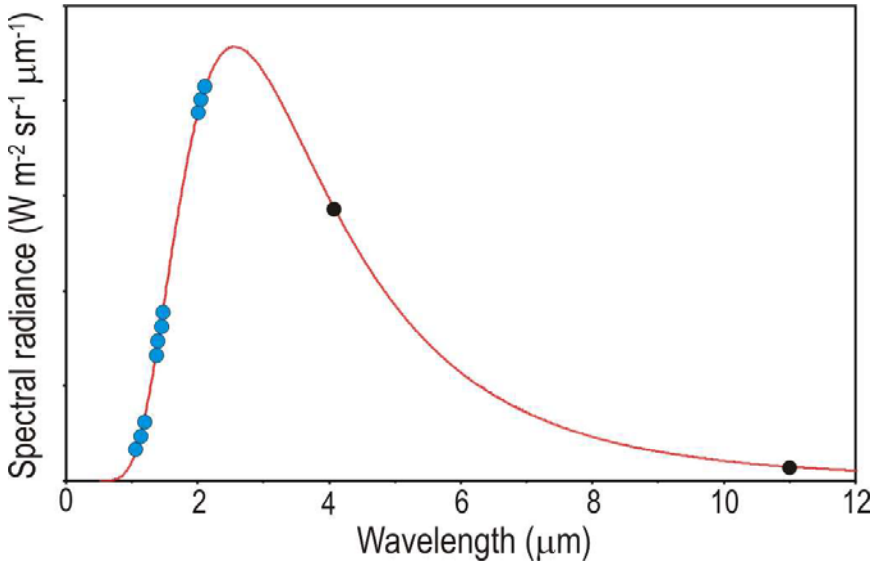

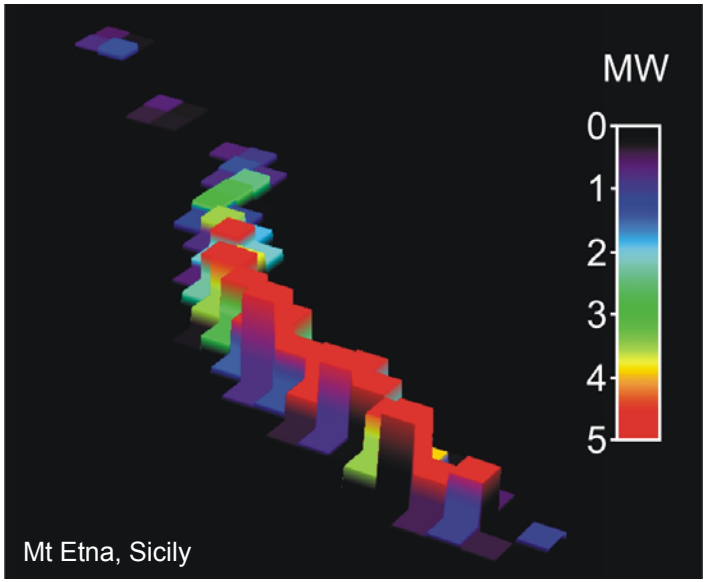

- By providing data in the NIR, SWIR, MIR and TIR, HyspIRI will allow for more accurate determination of lava surface temperature patterns than has been possible using ASTER/TM/ETM+.

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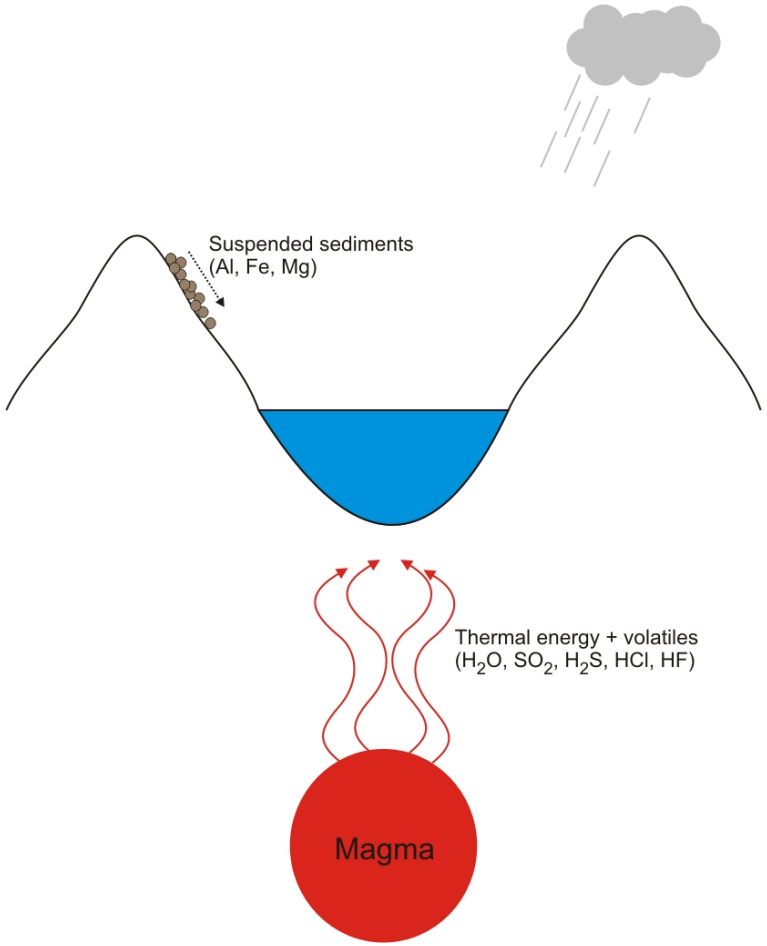
Does the temperature and composition of volcanic crater lakes change prior to eruptions? (DS 226; 227).



Irazu volcano, Costa Rica


Maly Semiachik, Russia

- Lakes act as chemical traps and calorimeters
- HyspIRI's TIR and VSWIR instruments will allow us to identify changes in the temperature, area, and color of volcanic crater lakes for changes (increased volatile flux, increased temperature, seismic activity) that may indicate volcanic unrest

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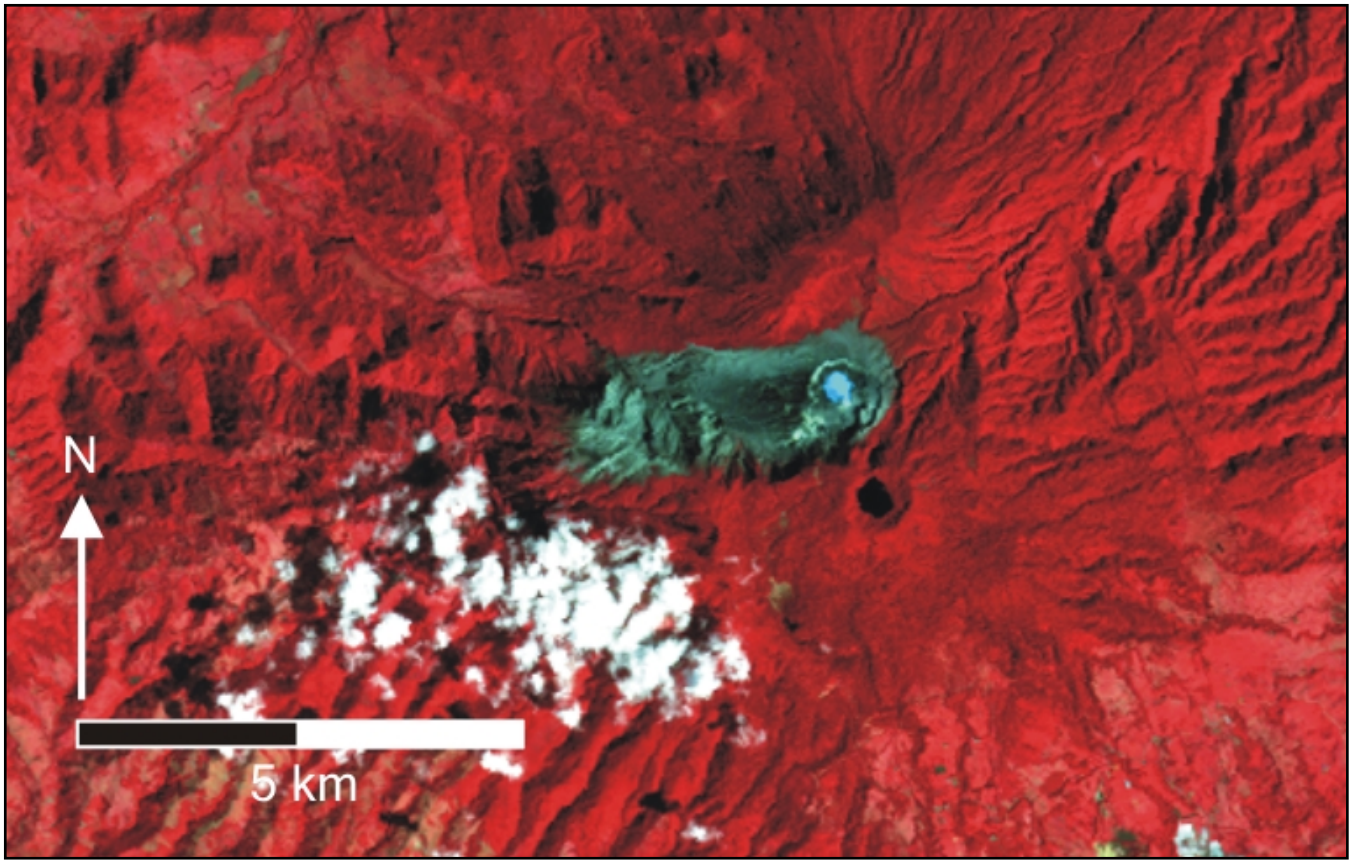
Do changes in the health and extent of vegetation cover indicate changes in the release of heat and gas from crater regions? (DS 230; 231)



Landsat TM, Poas volcano, Costa Rica

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• Does pressurization of the shallow conduit produce periodic variations in SO_2 flux and lava dome surface temperature patterns that may act as precursors to explosive eruptions? (DS 50; 227; 230)

• Can measurements of the rate at which lava flows cool allow us to improve forecasts of lava flow hazards? (DS 50; 226)

• Does the temperature and composition of volcanic crater lakes change prior to eruptions? (DS 226; 227).

• Do changes in the health and extent of vegetation cover indicate changes in the release of heat and gas from crater regions? (DS 230; 231)