Are there currently active volcanoes on Venus?

- Infra-red observations can look for recent and/or active lava flows
- SO₂ variability in atmosphere might be due to volcanic eruptions
- Change detection using images taken at different times
“Recent hotspot volcanism on Venus from VIRTIS emissivity data”

- “Recent” = less than 2.5 Myr
- VIRTIS = visible and infrared thermal imaging spectrometer on ESA’s Venus Express
- “Emissivity” = determines heat flux at a given temperature

One-sentence summary: VIRTIS was used to identify compositional differences which are attributed to unweathered (i.e. young) lava flows
Abstract
The questions of whether Venus is geologically active and how the planet has resurfaced over the past billion years have major implications for interior dynamics and climate change. Nine “hotspots”—areas analogous to Hawaii, with volcanism, broad topographic rises, and large positive gravity anomalies suggesting mantle plumes at depth—have been identified as possibly active. This study used variations in the thermal emissivity of the surface observed by the Visible and Infrared Thermal Imaging Spectrometer on the European Space Agency’s Venus Express spacecraft to identify compositional differences in lava flows at three hotspots. The anomalies are interpreted as a lack of surface weathering. We estimate the flows to be younger than 2.5 million years and probably much younger, about 250,000 years or less, indicating that Venus is actively resurfacing.

Why do it?

What did we do?

What did we find?

What does this mean?
Why do we care?

- Venus was resurfaced, but we don’t know whether it was catastrophic or continuous.
- If continuous, Venus is probably active now.
- So it is important to look for signs of current volcanic activity.
Logic

• Identify anomalously emissive areas (which are also stratigraphically young)
• Argue that the emissivity is because they are not yet weathered
• Use estimates of volumes of these flows and rates of melt production to determine flow age
VIRTIS & emissivity

- VIRTIS measures flux at different wavelengths
- There is a “window” at ~1 mm where infrared emitted from the surface can pass through the clouds
- We know this because the signal detected correlates with altitude (high peaks are colder) (Lecacheux et al. 1993)
- Flux emitted depends on temperature and emissivity \( F = \varepsilon \sigma T^4 \)
- If we know the temperature, we can measure \( F \) and find \( \varepsilon \)
- We can predict \( T \) because we know the topography, and \( T \) varies with altitude
- So we can measure the emissivity
Emissivity variations

Hmm... That is a worryingly strong correlation...
Anomalous areas

The high-emissivity flows are also thought to be stratigraphically young (based on other people’s mapping). This is a good sign.
What controls emissivity?

• Experiments and theory suggest that emissivity decreases as weathering proceeds.

• Or the emissivity might appear high because the region is hotter than it should be (i.e. the lava flow is still hot). This is less likely, because the implied temperature difference is only 20K [seems low?]

• So these regions are probably young. But how young?

• We don’t know how rapidly weathering happens.
How recent?

• Estimate volume $V$ of anomalous flows (thickness guessed at)
• Estimate rate of melt production $R$ (based on crater counts and $\text{SO}_2$ outgassing)
• Find time since flows were emplaced: $t = V/R$

• They argue that this probably overestimates the flow age
• They derive flow ages of 0.25-2.5 Myr
So what?

- Recent volcanism means Venus is more Earth-like
- Continuous not episodic resurfacing implied

This is always a good question to end with
Comments

- Age calculation is not strong (and potentially circular argument!)
- How could we test this hypothesis further?
- It would be really valuable to get better constraints on weathering rates