

Volcanic
Fields on
Earth & Mars

Jacob
Richardson

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Sills

Lava Flows

Vent Density

Mars Clusters

Arsia Mons
Volcanic Field

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Modeling the Construction and Evolution of Distributed Volcanic Fields on Earth and Mars

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University of South Florida

19 February 2016

Acknowledgements

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Some Collaborators

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James Wilson

Lis Gallant

Julia Kubanek

Jake Bleacher

Lori Glaze

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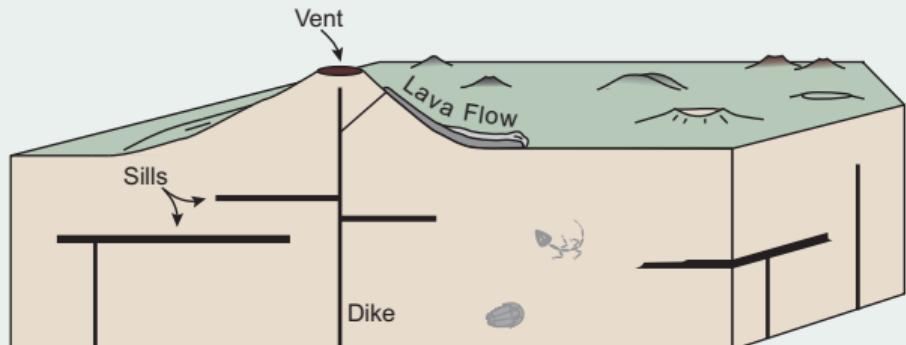
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Distributed-style Volcanism

Characteristics:

- Clusters of volcanoes are formed
- Single eruptions at each location
- Isolated dikes ascend individually
- Long periods of quiescence



Outline of Talk

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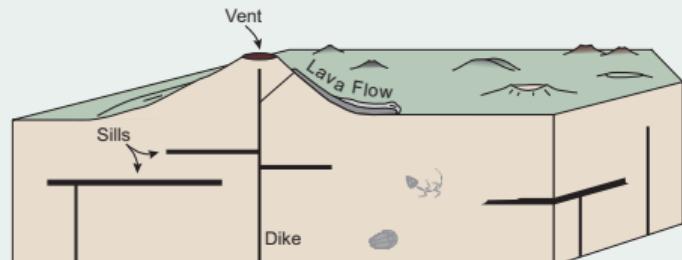
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- Overview of Dissertation
 - The role of sills in the formation of volcanic fields
 - Simulating lava flows
 - The spatial organization of volcanoes in volcanic fields
 - The history of a volcanic field on Mars, Syria Planum
- Waning volcanism at Arsia Mons, Mars
 - Mapping the latest volcanism at Arsia
 - Estimating eruption timing, magnitude
 - Implications of the rate of volcanism
- Conclusions



Sills in the San Rafael Swell

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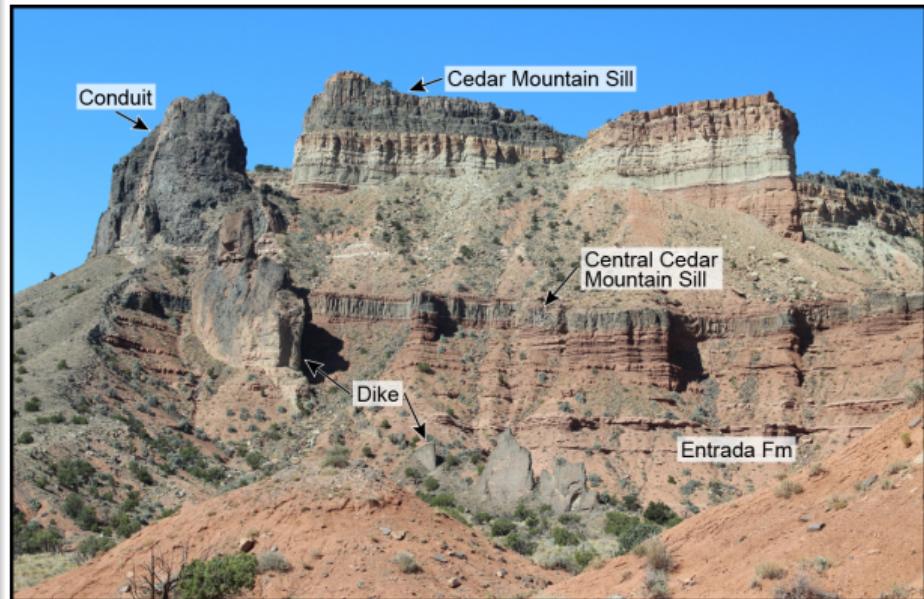
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San Rafael Volcanic Field, Utah

- Pliocene volcanic activity
- Now eroded to depth of ~1 km
- Sills and Dikes exposed



Chuck Connor with a Terrestrial Lidar



Sills in the San Rafael Swell

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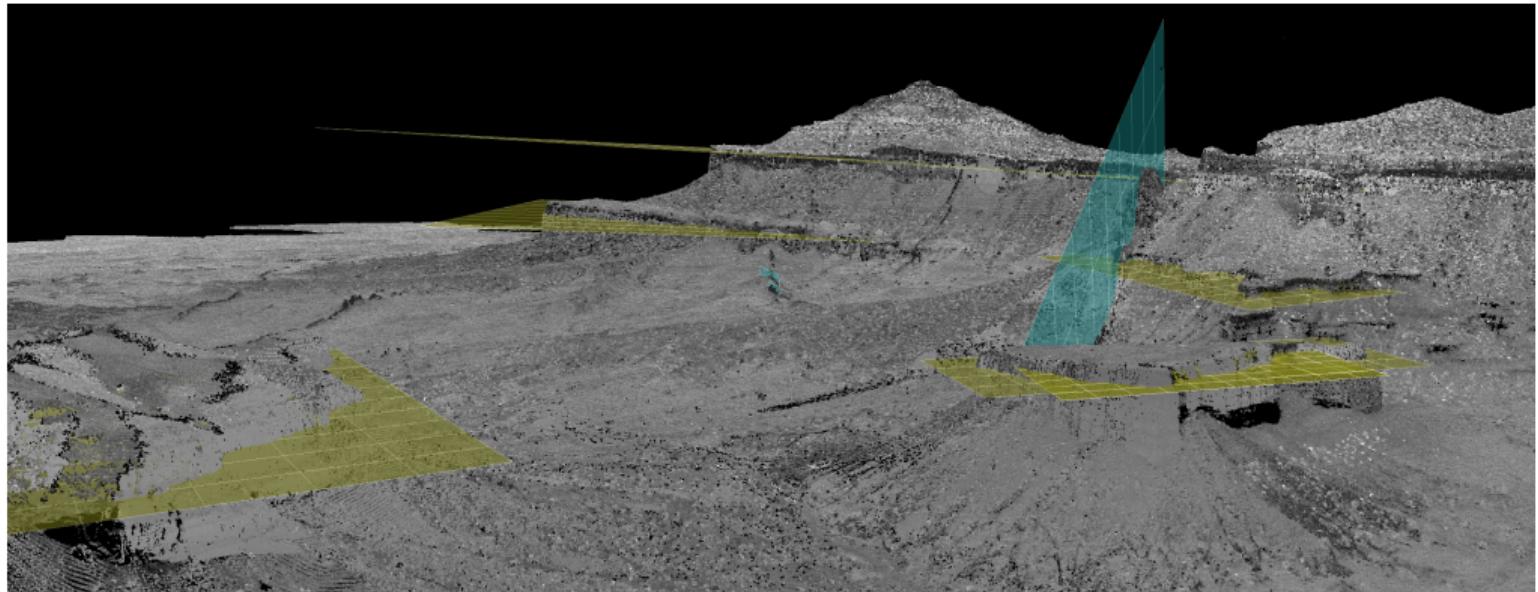
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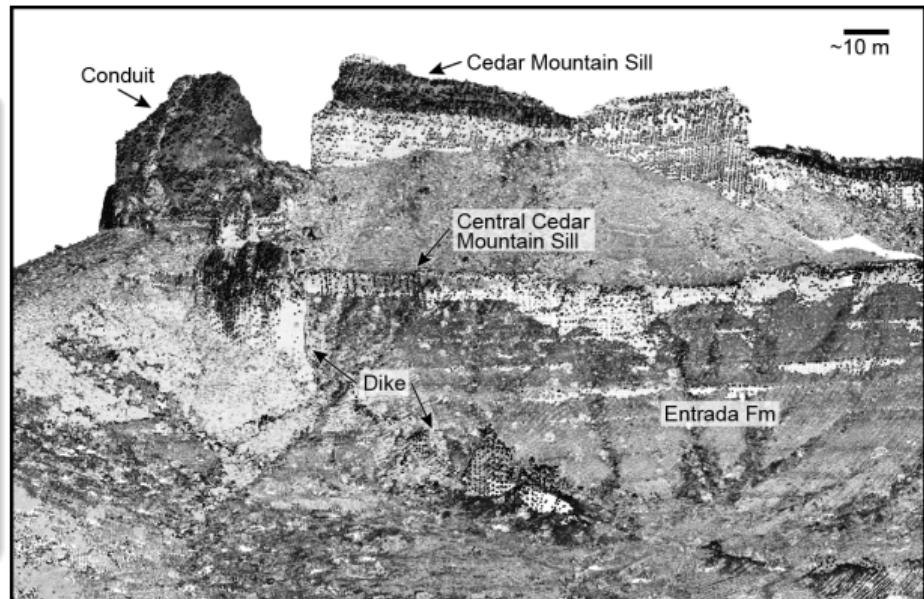
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Results of lidar survey

- >90% of igneous rock is stored in sills
- Sill volume comparable to volume thought to have erupted at surface
- Sills had ability to modulate eruption style



Lava Flows/Simulators

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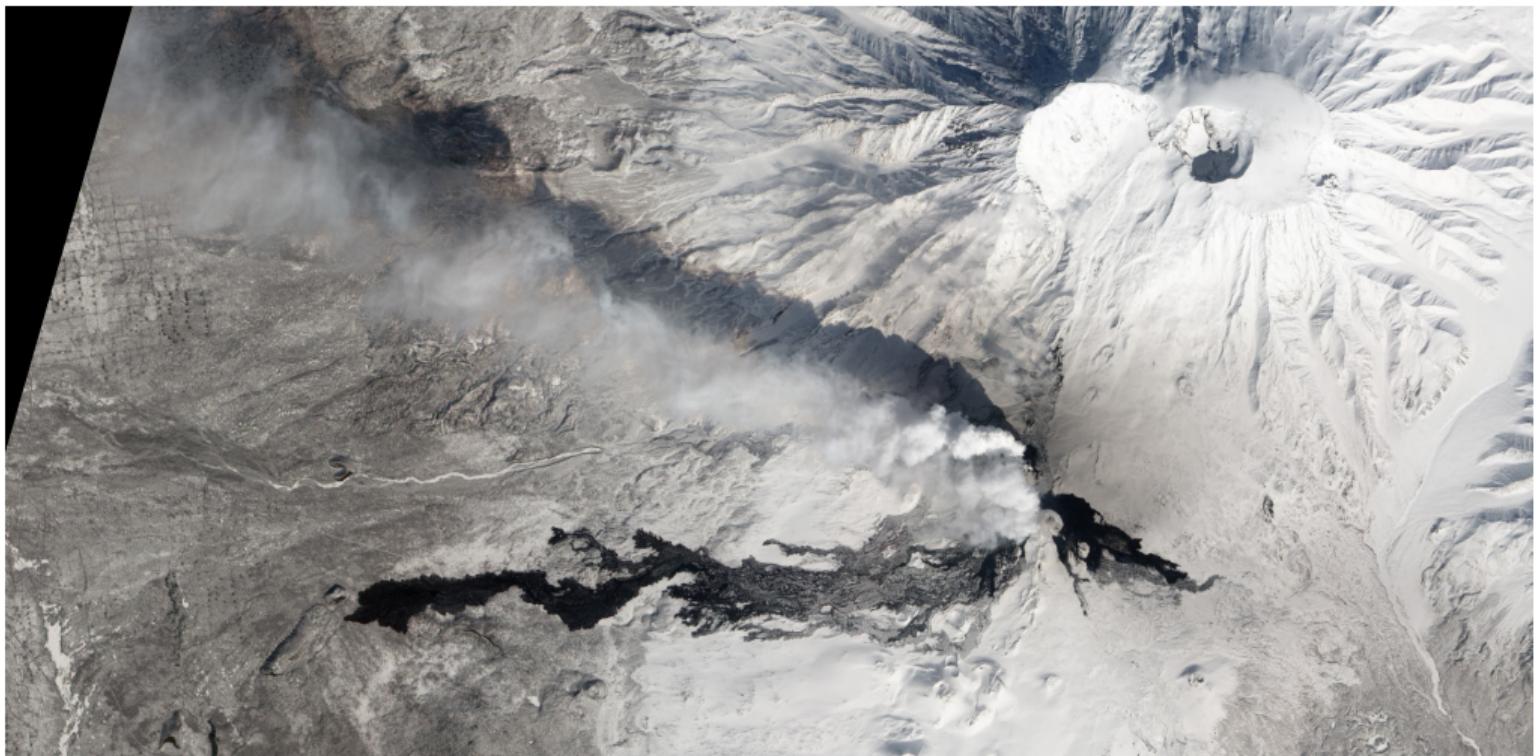
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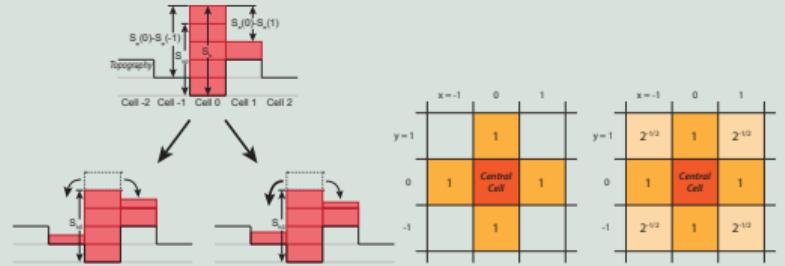
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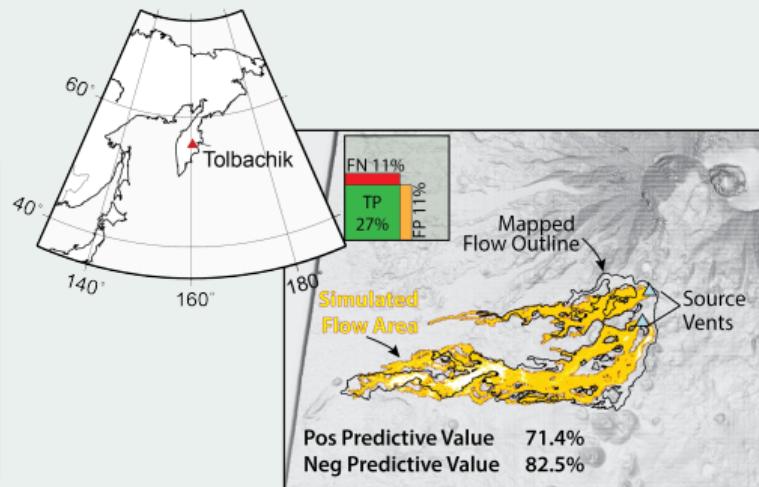
MOLASSES — Modular Lava Simulation Software

- MOLASSES developed after Connor et al. 2012
- Spreads lava over a grid according to universal rules

Optional Spreading Rules



Using TanDEM-X satellite data, flow simulations match the 2012-3 Tolbachik flow between 70-85%.

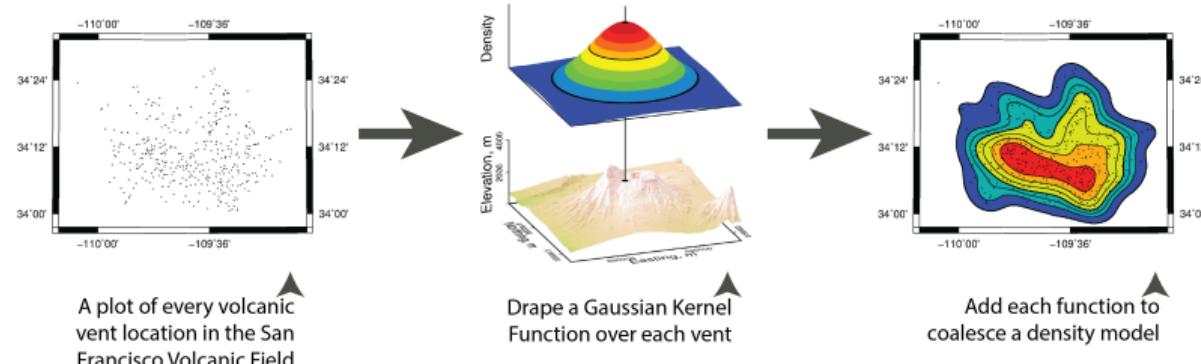


Spatial Density of Clusters

- Spatial density of volcanoes is modeled by Kernel Density Estimation
- Size of volcanic field determined by a set contour (95%)

$$\text{Average vent intensity} = \frac{\text{volcanic vents}}{\text{field area}}$$

- This is applied to fields on Earth, Mars, and Venus



Spatial Density of Clusters

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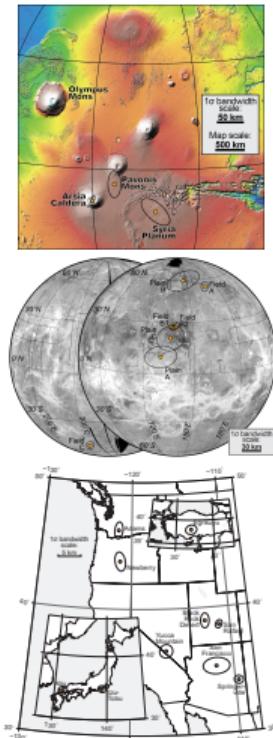
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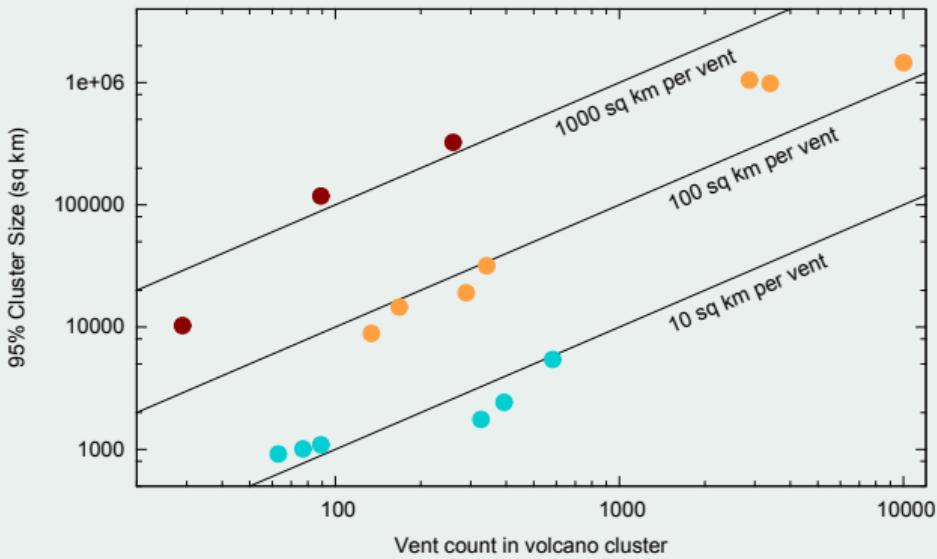
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Average Vent Intensity, Colored by Planet



Syria Planum

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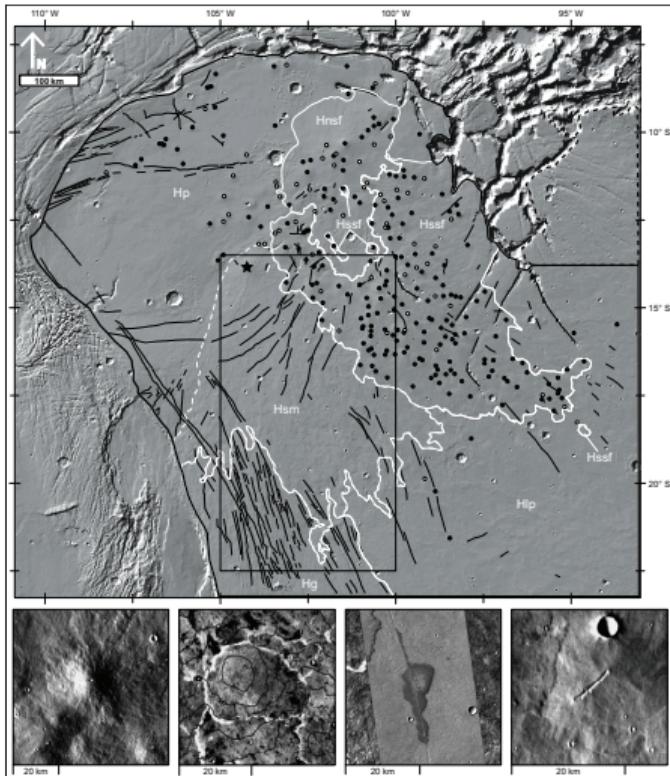
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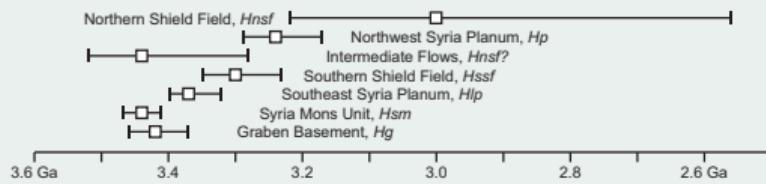
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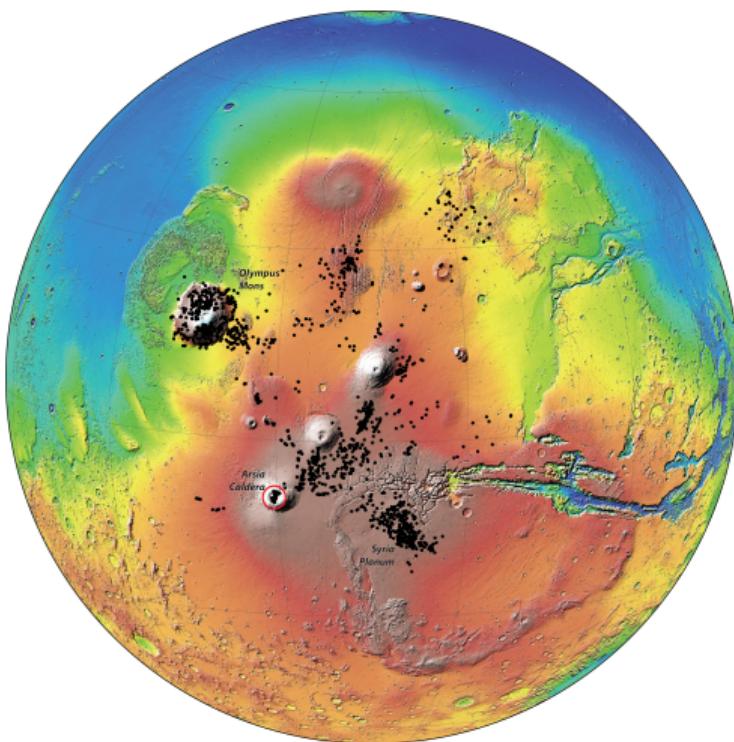


Evolution of a Martian volcano cluster

- Volcanic vents have been cataloged on Syria Planum
- Volcanic units are ID'd with geomorphology and embaying flow fronts
- Region was active for 900 Ma (3.5-2.6 Ga)
- volcanism center shifted with time



Distributed Volcanism of the Tharsis Volcanic Province



Tharsis Vent Catalog

Catalog created by J. Bleacher et al.

Arsia Mons Overview

Arsia Mons

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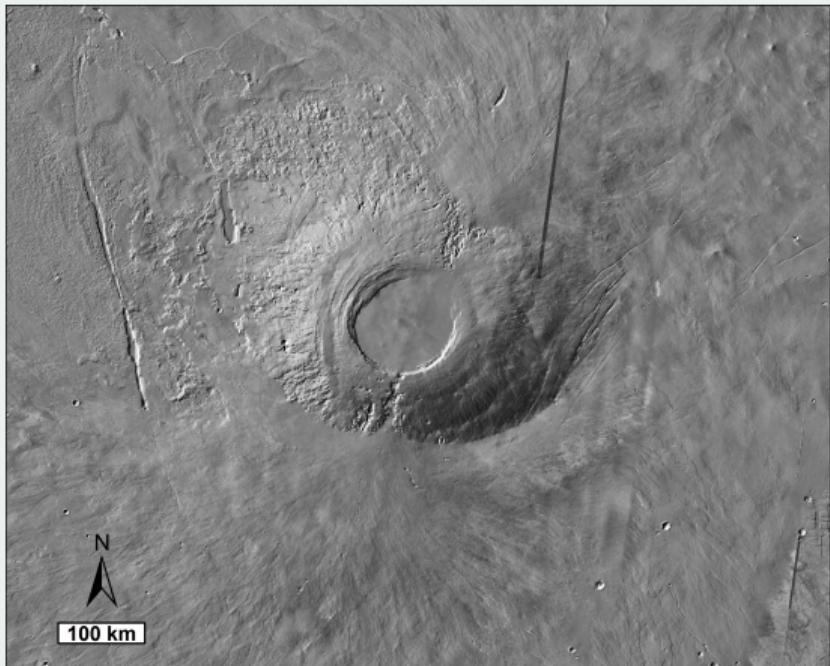
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Arsia Mons is here:



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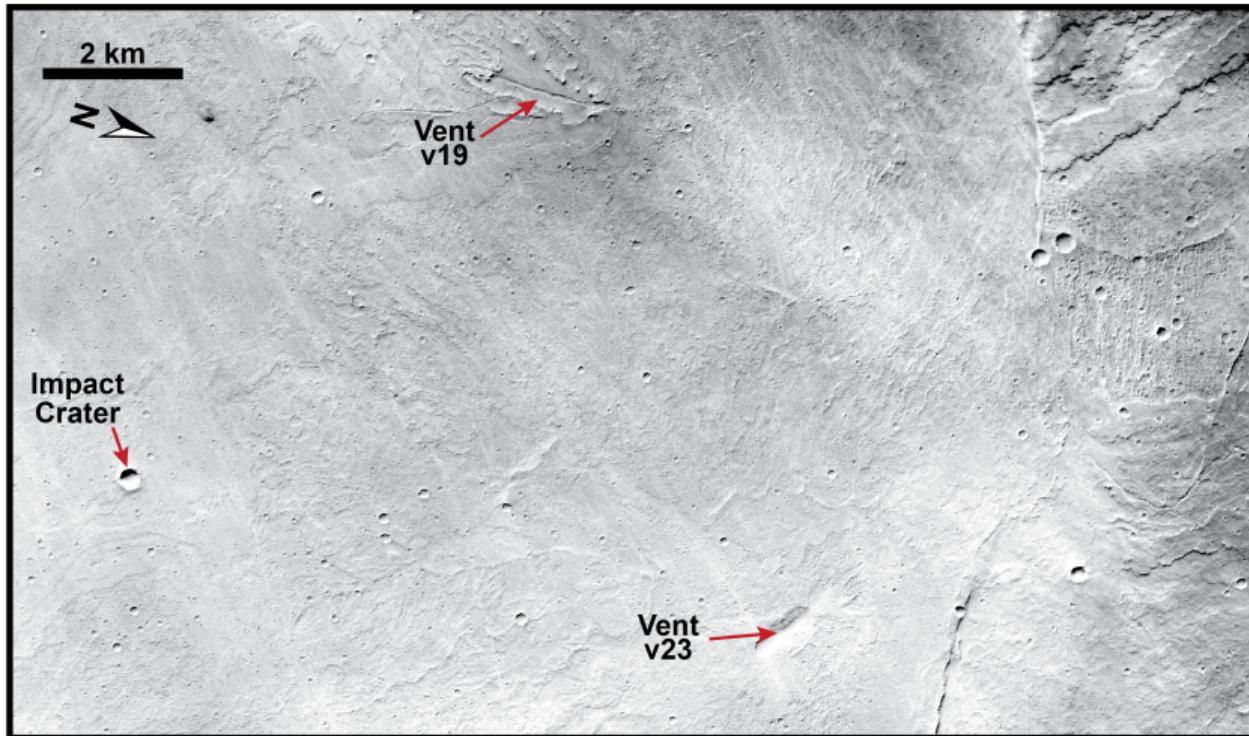
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CTX Image: G10_022160_1710_XN_09S120W (NASA/JPL-Caltech/MSSS)

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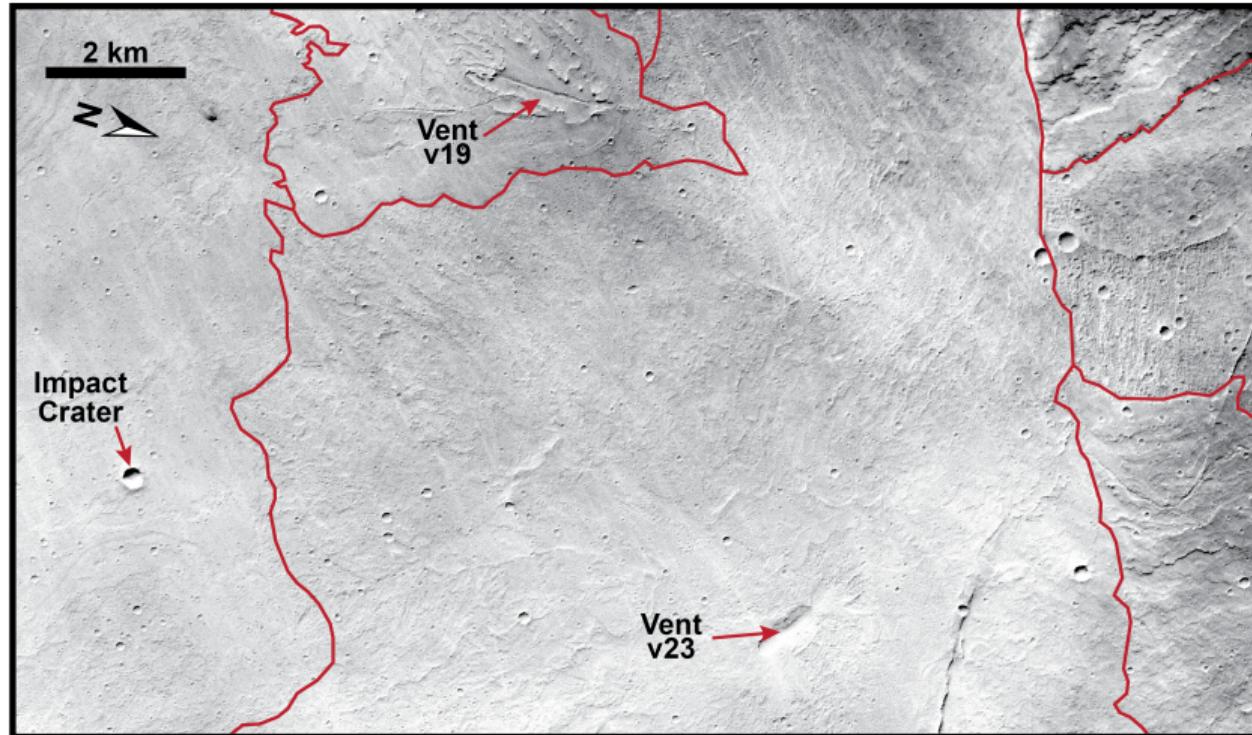
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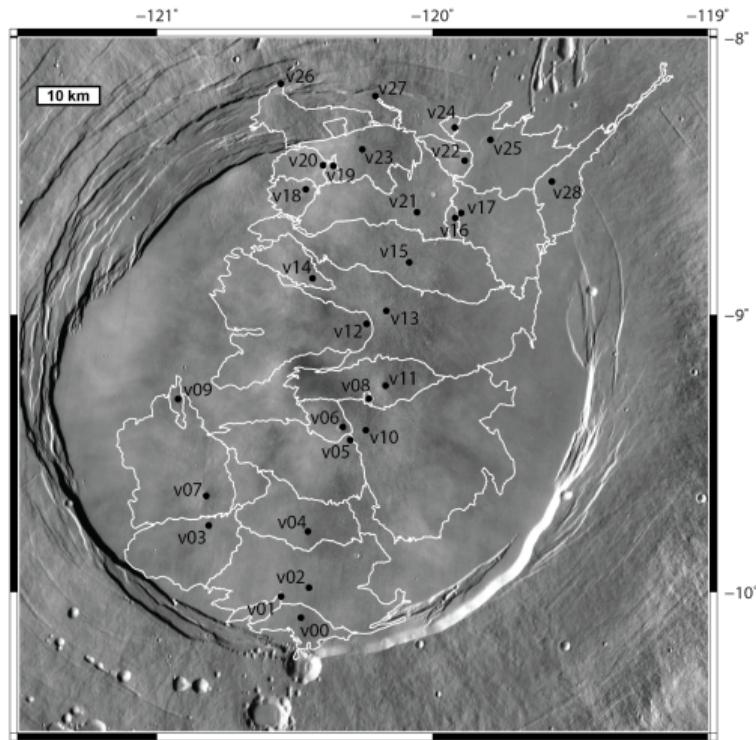
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29 vents are mapped

Ages: Crater Counting

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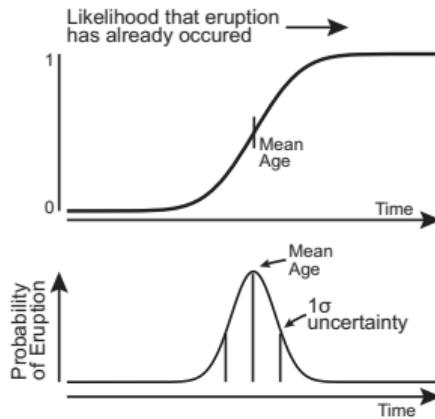
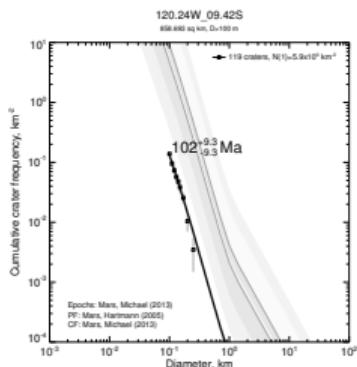
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Ages: Stratigraphy

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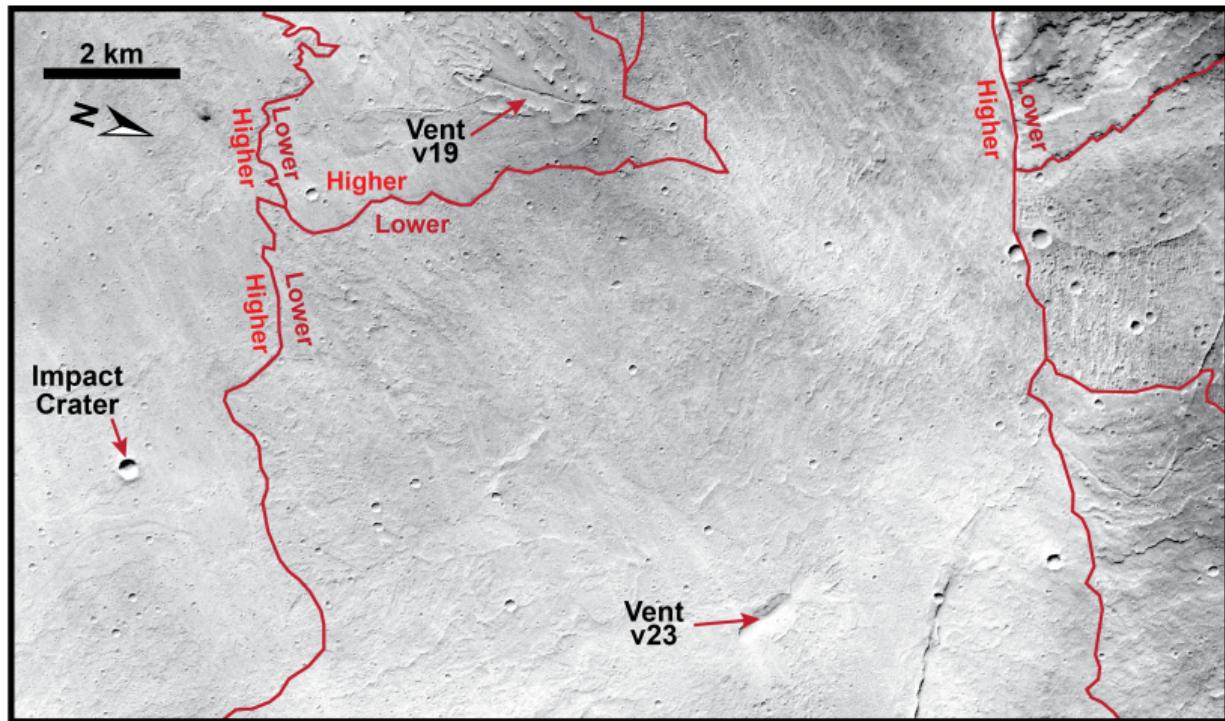
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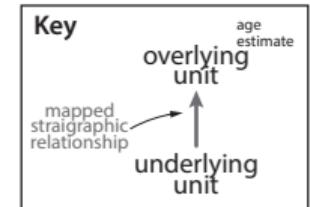
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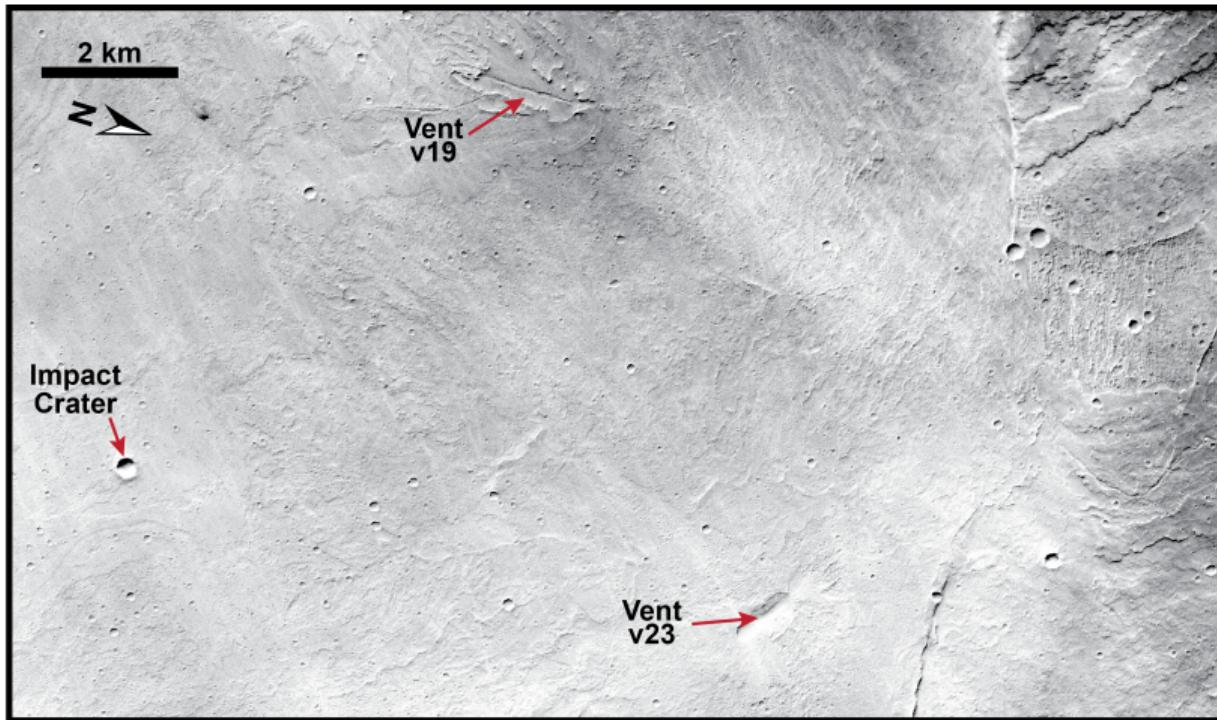
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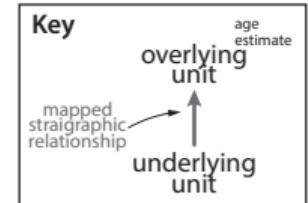
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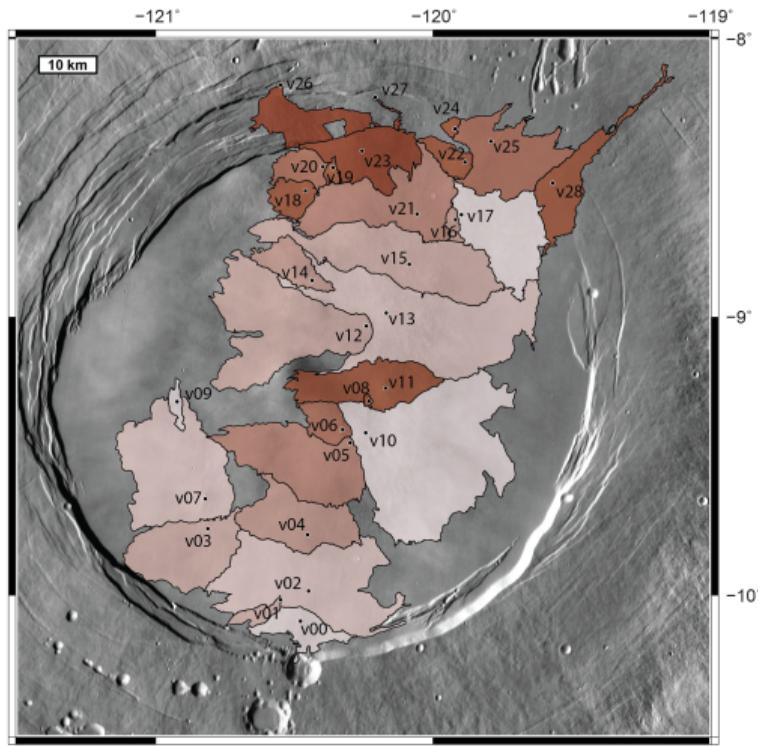
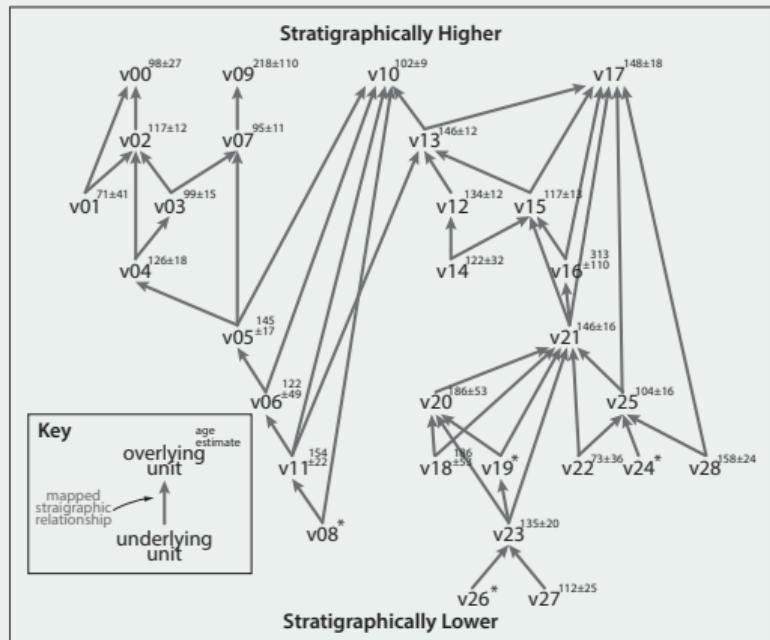
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Stratigraphy “Web”



Ages: Information Conflicts

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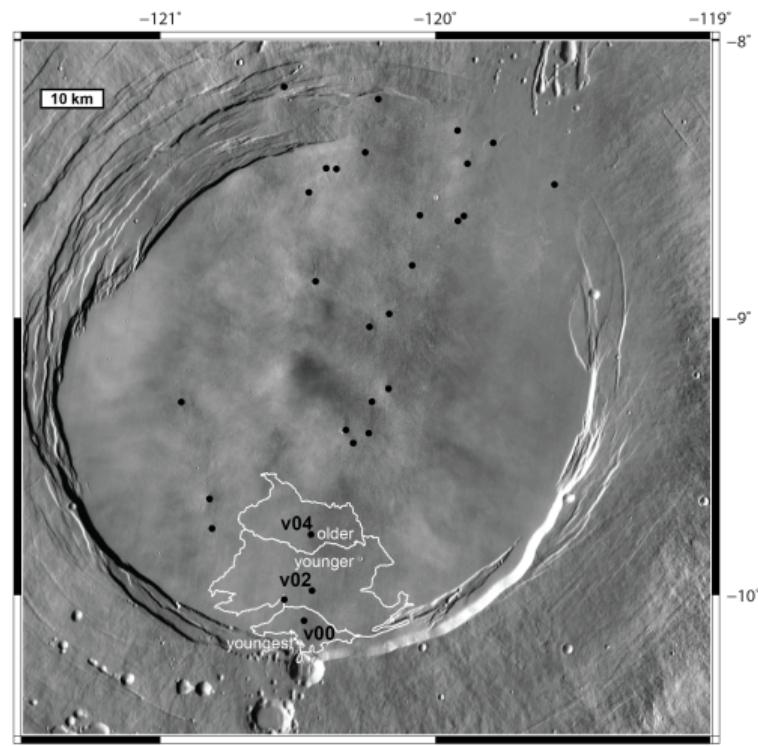
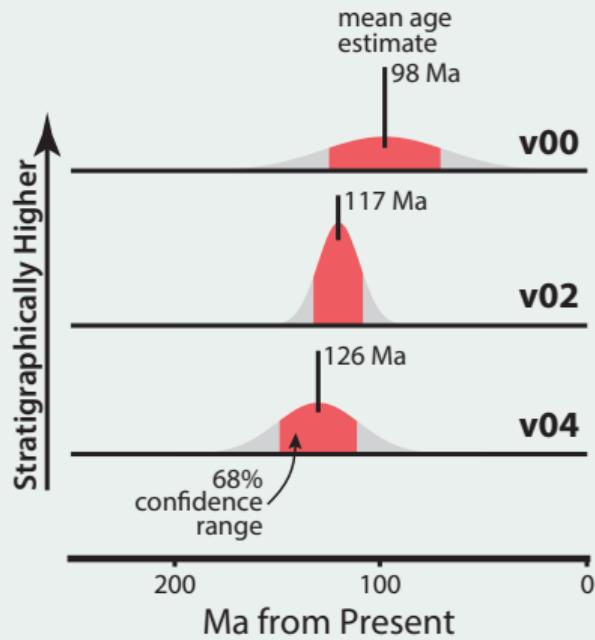
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Mean crater ages can agree stratigraphy...



Ages: Information Conflicts

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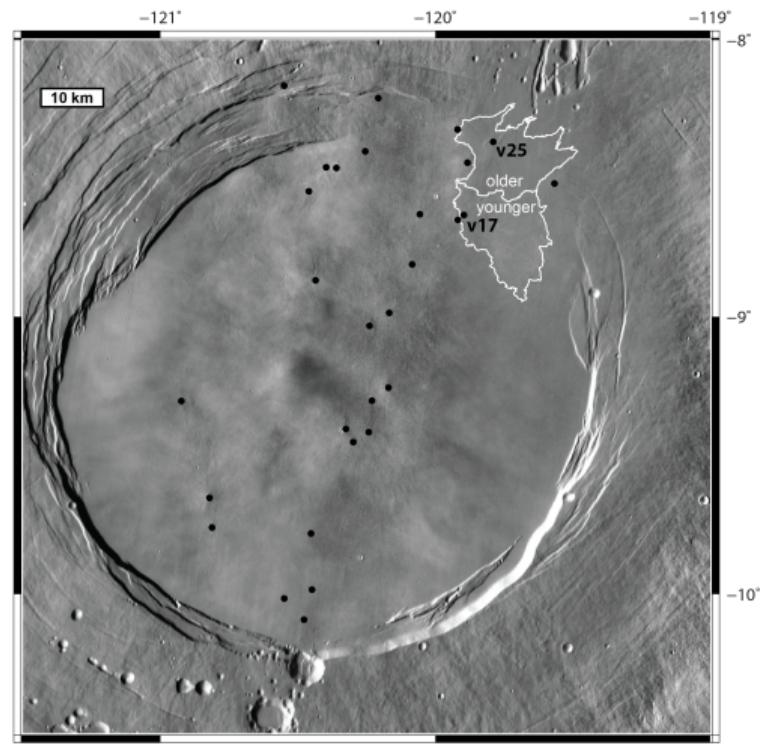
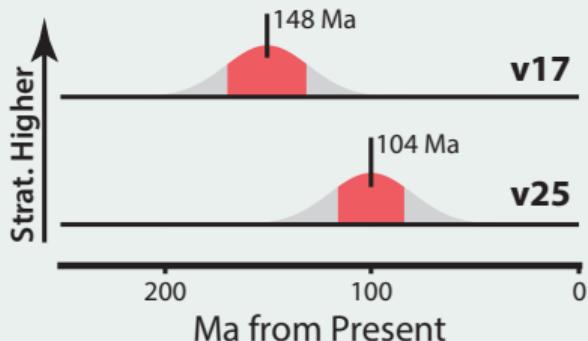
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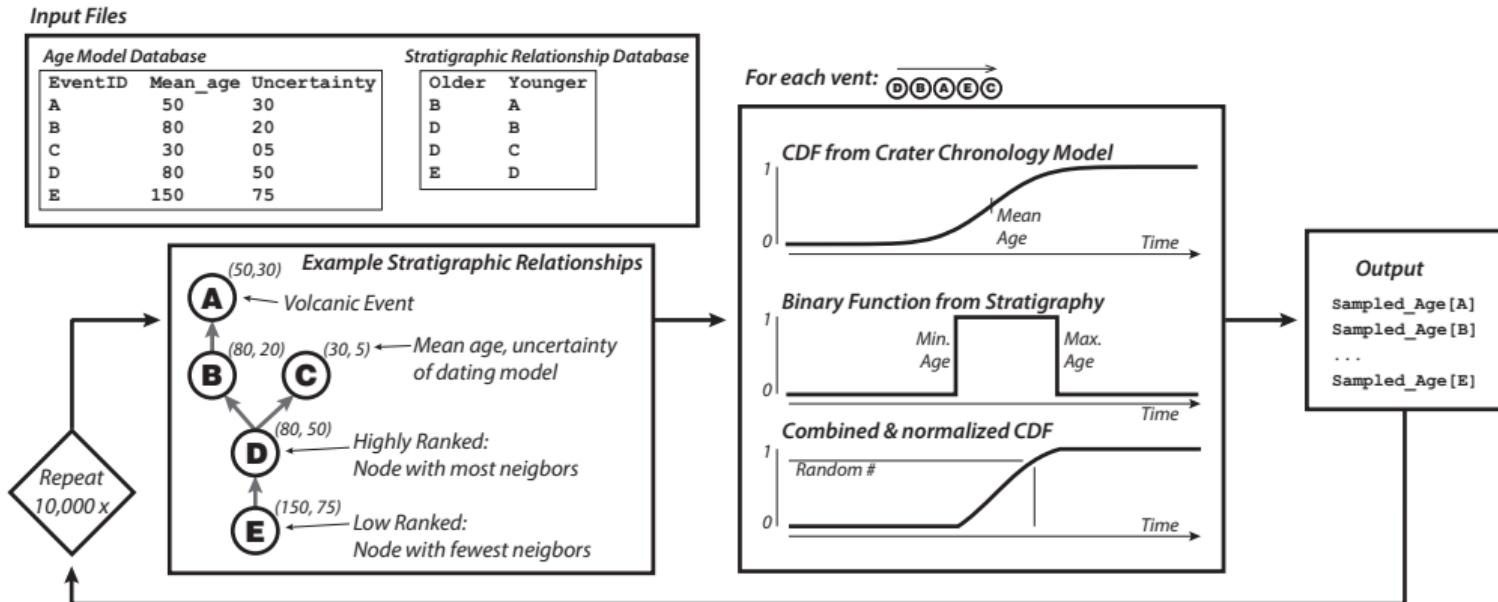
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... or they can disagree





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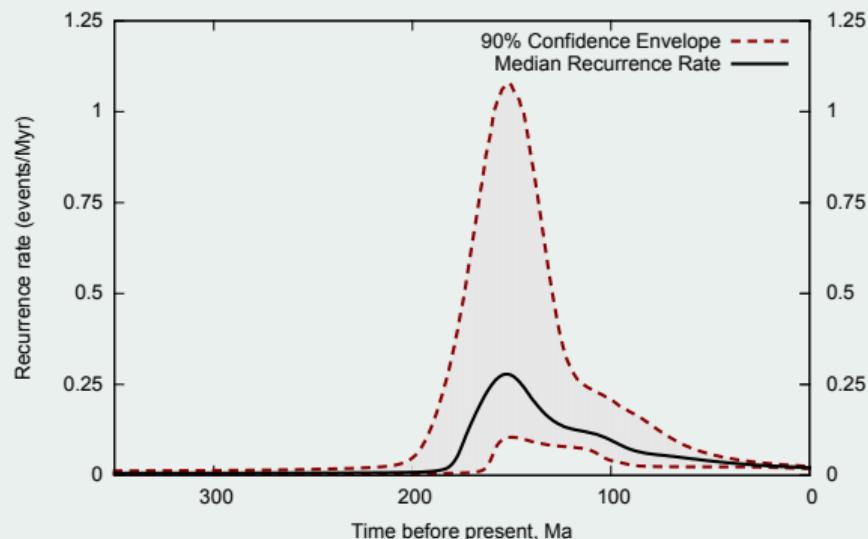
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Recurrence Rate



Volume Flux

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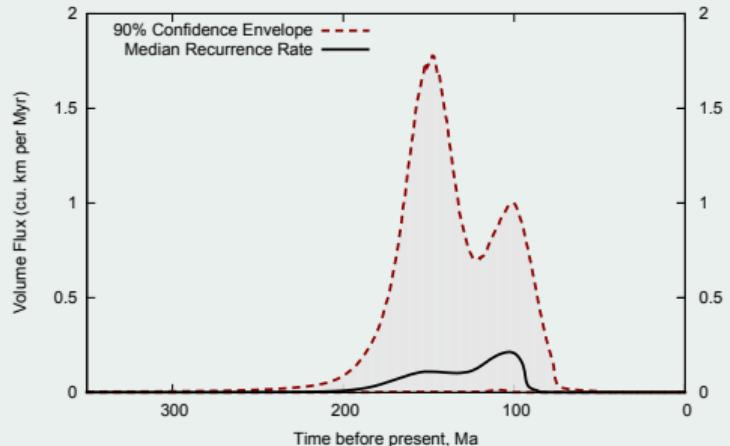
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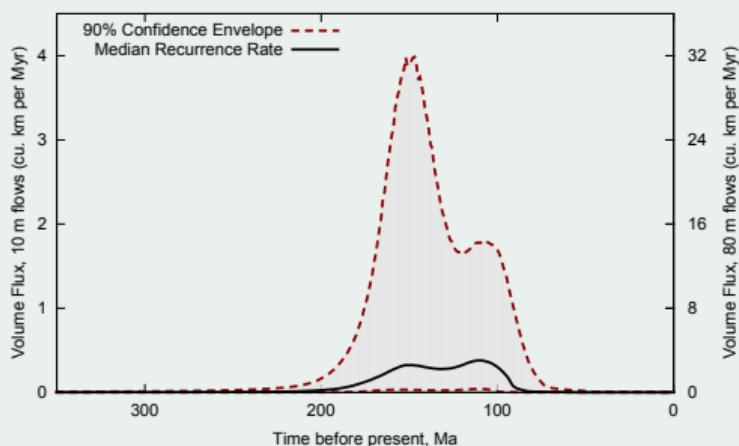
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Sub-surface mesh model



Thickness model



Tie in with Ashes and glaciers?

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Model of waning volcanism of Arsia

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Additional Thanks

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