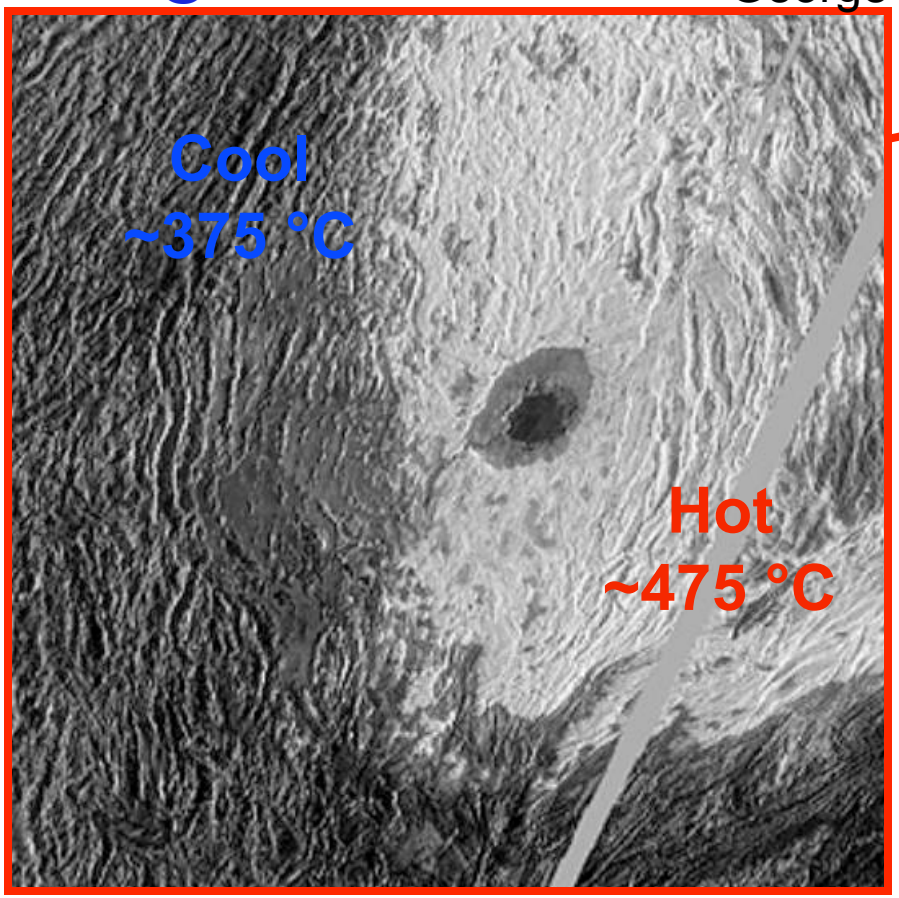
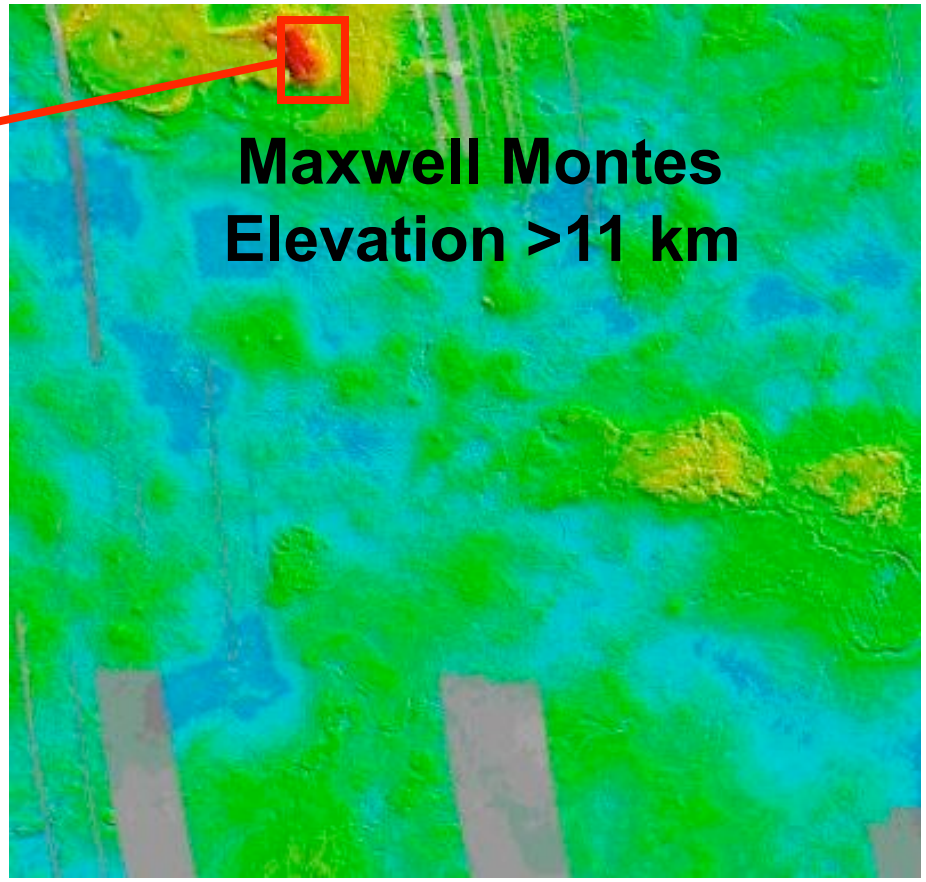
Anomalous Radar Reflectivity of the Venus High Regions

friedemann.t.freund@nasa.gov
robert.dahlgren@sjsu.edu
cwill51@k-state.edu
tsoflias@ku.edu

Friedemann Freund
Robert Dahlgren
Colin Williams
George Tsoflias

Collaboration
NASA Ames Research Center
San José State University
SETI Institute





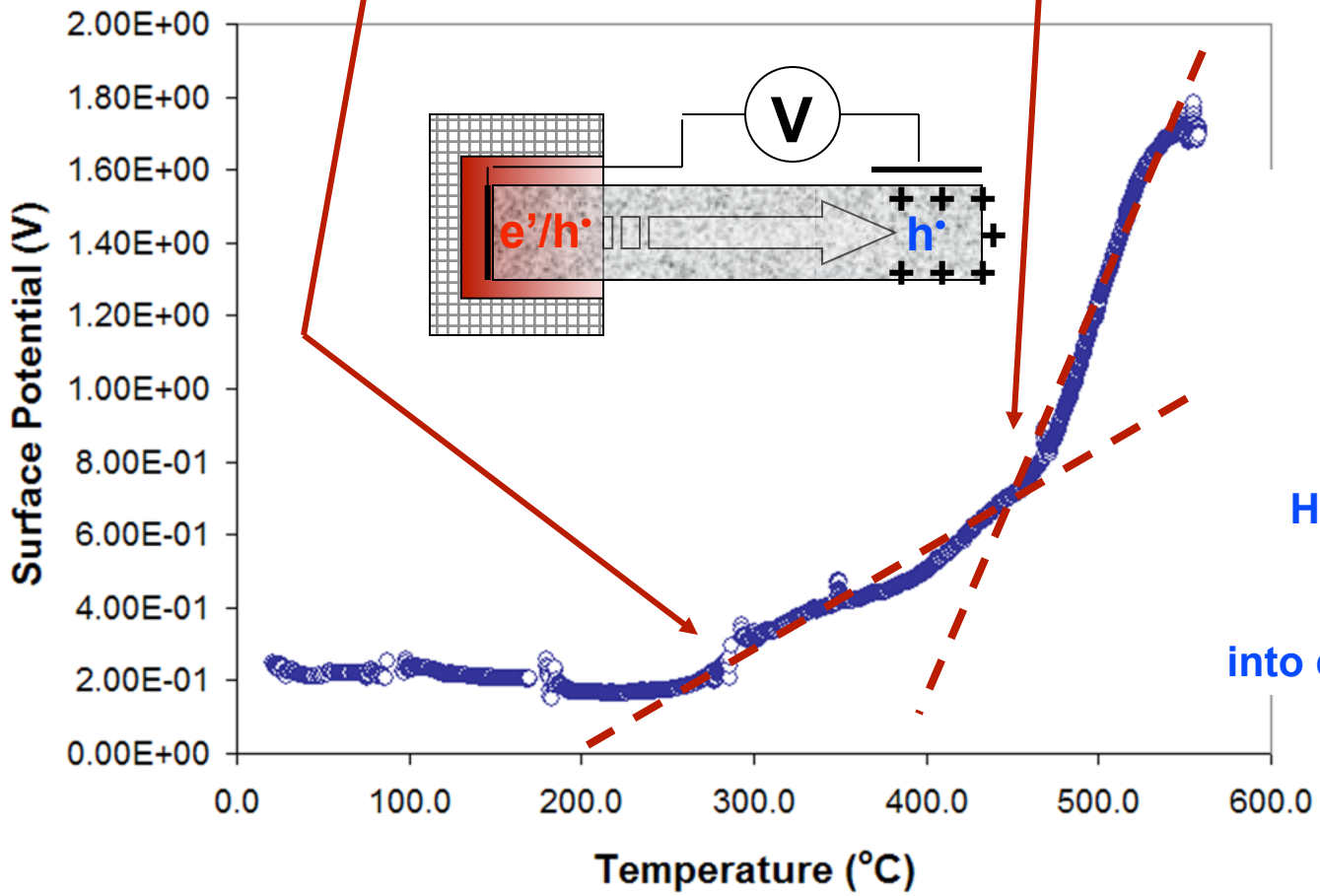
Images courtesy NASA Magellan

Thermal 2-stage activation of positive hole charge carriers in rocks: Surface Potential

Step I ~300°C — Step II ~430°C — e' — Trapped e'

$O_3Si/^{OO}\backslash SiO_3 + O^{2-} \leftrightarrow O_3Si/^{O}:_{O}/SiO_3 + O^{2-} \leftrightarrow O_3Si/^{O}\bullet_{O}/SiO_3 + O^{-}$

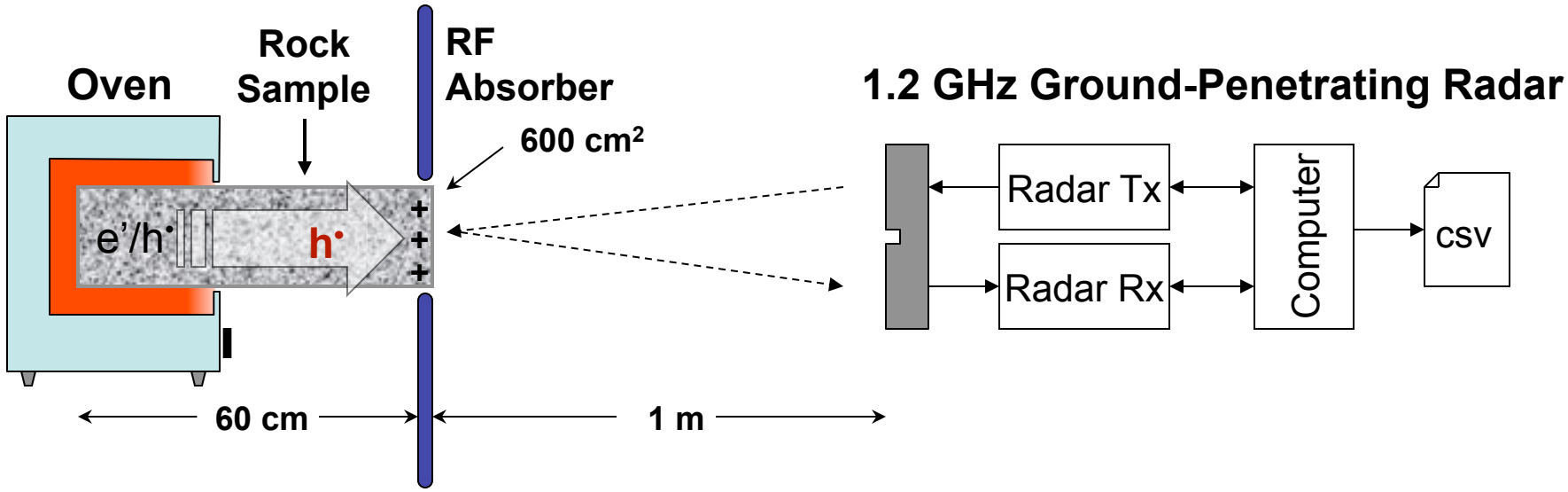
Dormant — Spin-decoupled — Dissociated

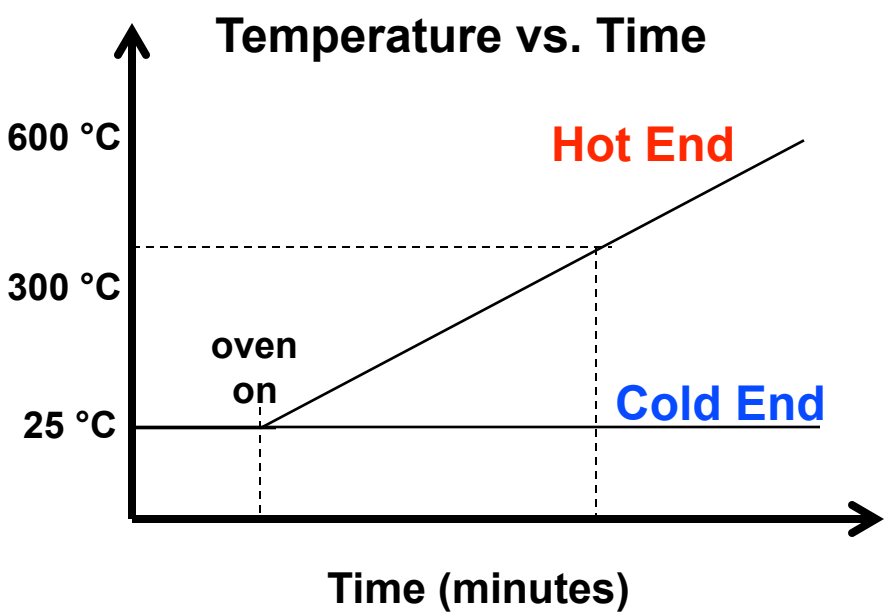


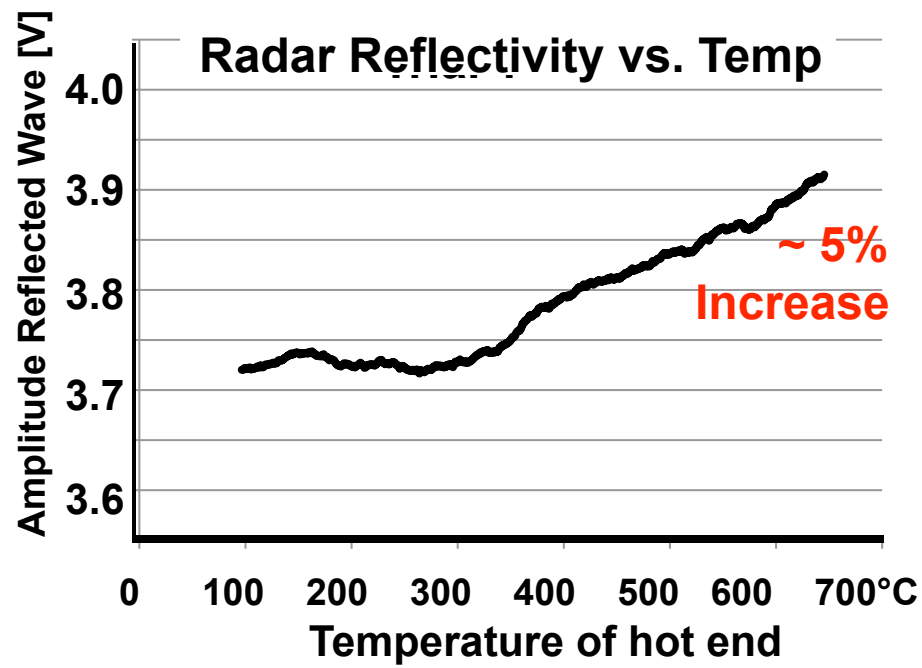
h• positive hole charge carrier

Highly mobile, flow out of hot rocks into colder rocks.

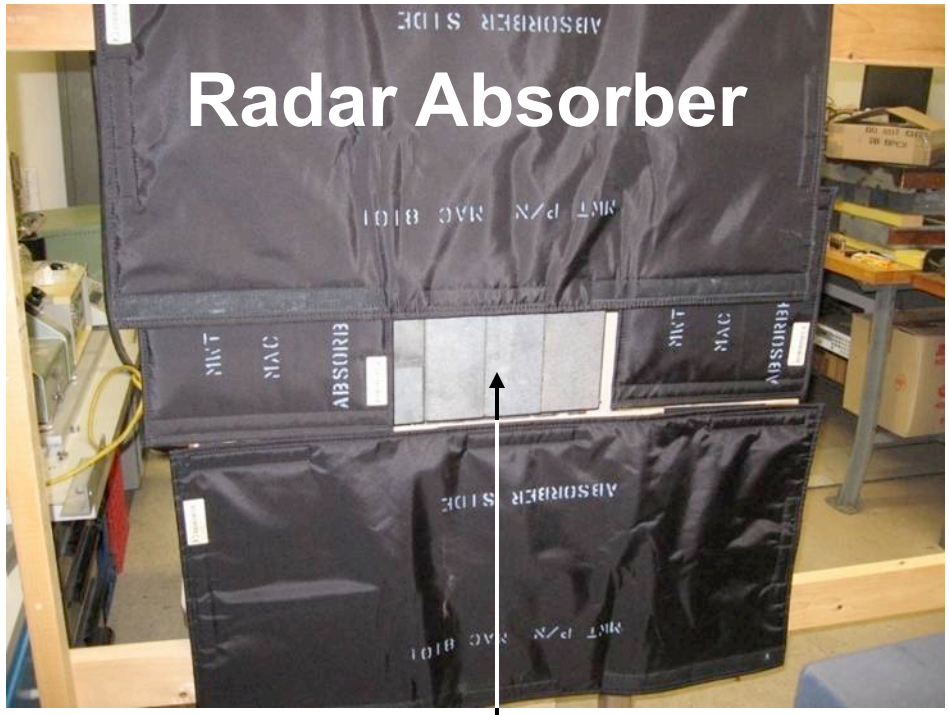
Radar Reflectivity from the Cold End of Gabbro







Experiment Photographs



Cold rock surface

Oven behind radar absorber not shown

Radar Controller

Laptop PC

Transmitter & Receiver

Summary and Hypothesis

- Igneous rocks contain dormant **peroxy** defects, **O_3Si-OO-SiO_3**.
- Temperature breaks the O^{-}-O^{-} bond, releasing **$h^{\bullet}$**, positive hole charge carriers in 2 steps: ~300°C and more profusely ~430°C.
- The **$h^{\bullet}$** are highly mobile, while electrons remain trapped.
- **$h^{\bullet}$** density ~10^{18} cm^{-3}; phase velocity ~200 m/s; lifetime <10^{3} s.
- When activated in the hot end, the **$h^{\bullet}$** flow out to the cool end.
- Due to mutual electrostatic repulsion, the **$h^{\bullet}$** repel each other.
- They diffuse to the surface forming a surface charge layer.
- On the surface the electronic states become more delocalized, leading to high electrical conductivity and high radar reflectivity.
- Anomalous high radar reflectivity of high mountains on Venus such as Maxwell Montes may be due to a surface charge layer.