Anomalous Radar Reflectivity of the Venus High Regions

Images courtesy NASA Magellan

Friedemann Freund
Robert Dahlgren
Colin Williams
George Tsoflias

Collaboration
NASA Ames Research Center
San José State University
SETI Institute

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

Cool
~375 °C

Hot
~475 °C

Maxwell Montes
Elevation >11 km
Thermal 2-stage activation of positive hole charge carriers in rocks: Surface Potential

\[
\begin{align*}
O_3\text{Si}/O\backslash\text{SiO}_3 + O^2- &\quad \text{\(-300°C\)} & O_3\text{Si}/O\cdot\text{SiO}_3 + O^2- &\quad \text{\(-430°C\)} \\
&\quad \text{Dormant} & &\quad \text{Dissociated}
\end{align*}
\]

\[
\begin{align*}
O_3\text{Si}/O\cdot\text{SiO}_3 + O^- &\quad \text{\textit{Trapped }e'}
\end{align*}
\]

Highly mobile, flow out of hot rocks into colder rocks.
Radar Reflectivity from the Cold End of Gabbro

Temperature vs. Time

- **Cold End**: Oven on
- **Hot End**: oven off

Radar Reflectivity vs. Temp

- Approximately 5% increase

- 1.2 GHz Ground-Penetrating Radar
- RF Absorber: 600 cm²
- Radar echoes
- Data collected in a computer and saved as a CSV file
Experiment Photographs

Radar Absorber

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 $O^-\text{-}O^-$ bond, releasing $h^\cdot$, positive hole charge carriers in 2 steps: $\sim300^\circ C$ and more profusely $\sim430^\circ C$.
- The $h^\cdot$ are highly mobile, while electrons remain trapped.
- $h^\cdot$ density $\sim10^{18}$ cm$^{-3}$; phase velocity $\sim200$ m/s; lifetime $<10^3$ s.
- When activated in the hot end, the $h^\cdot$ flow out to the cool end.
- Due to mutual electrostatic repulsion, the $h^\cdot$ 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.