Genetic Geological Modelling for Lunar Resources

West Tranquillitatis Ti-rich deposit

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Outline

Genetic geological models

Definition

Value

Could they be applied to the Moon?

Ti-rich deposits

Selection rationale

Method

TiO_2 distribution

West Tranquillitatis deposit

Volcanic features

Predicted protoliths

Application to regolith formation

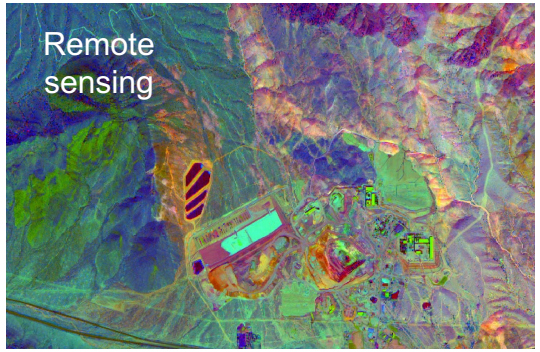
Concluding remarks

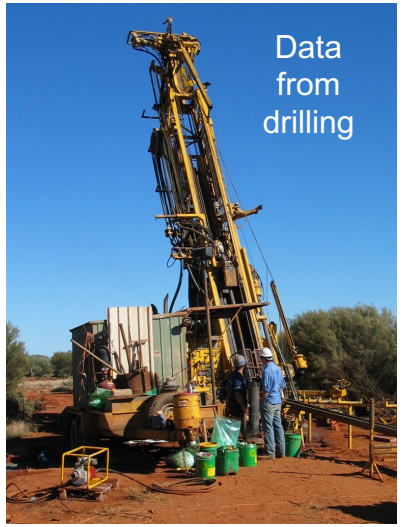
Genetic geological models

Insights into the formation and origin of mineral deposits

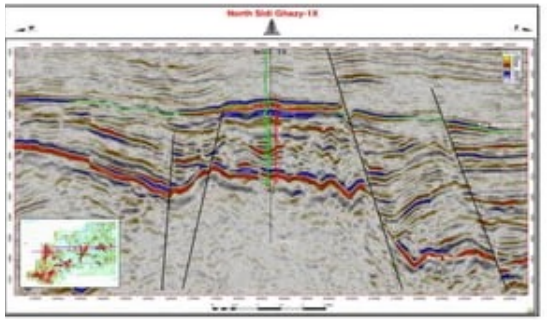
Genetic geological models are conceptual frameworks for the processes and origin of mineral deposits.

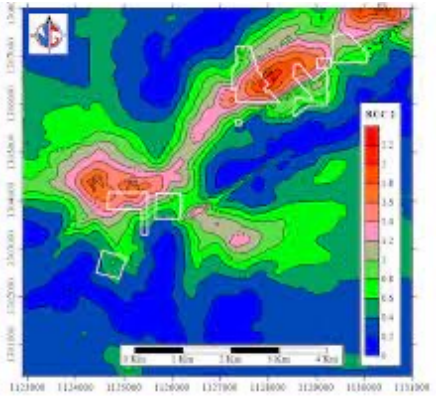
Geological factors: rock type, mineralization style, structural controls, alteration patterns, etc.



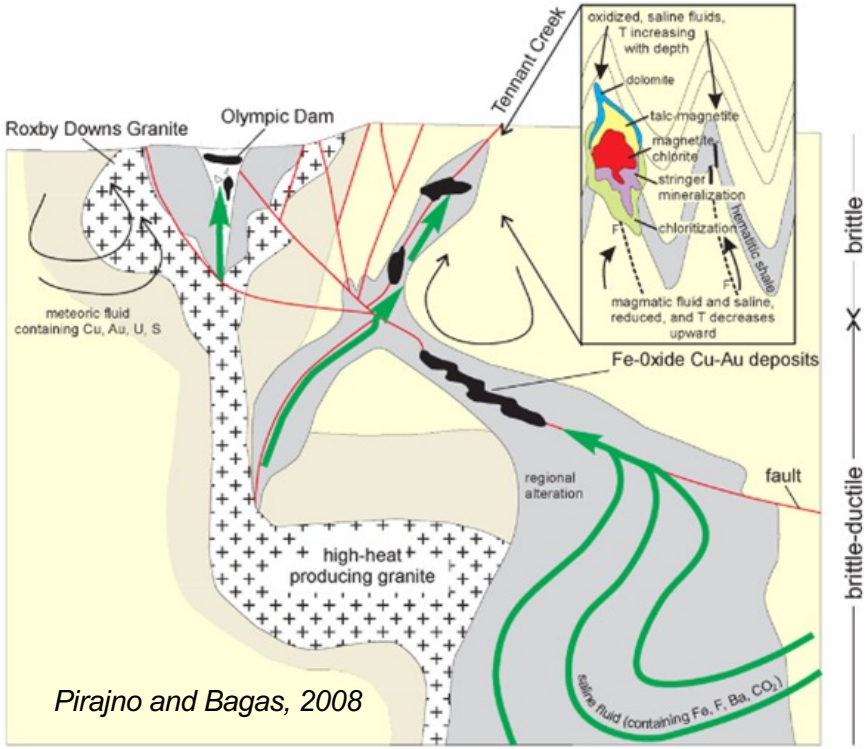


Geophysical surveys





Geochemical analyses



Model for the formation of Fe oxide Cu-Au deposits at different crustal levels (adapted from Davidson, 2002, Ahmad et al., 1999 and Solomon et al., 2000)

Genetic geological models

Value

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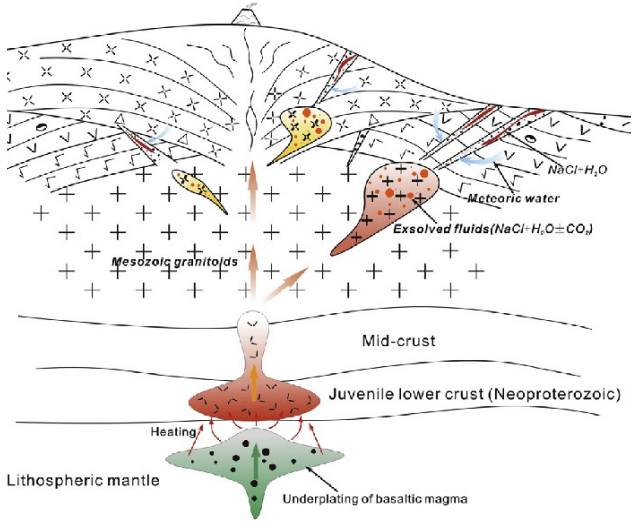
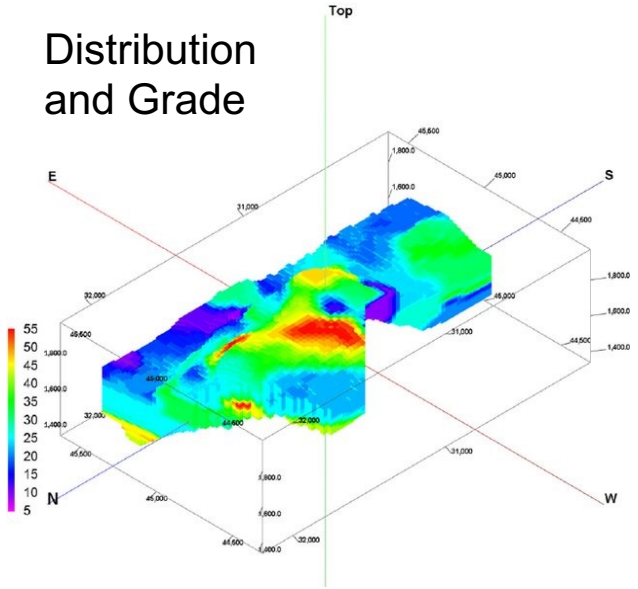
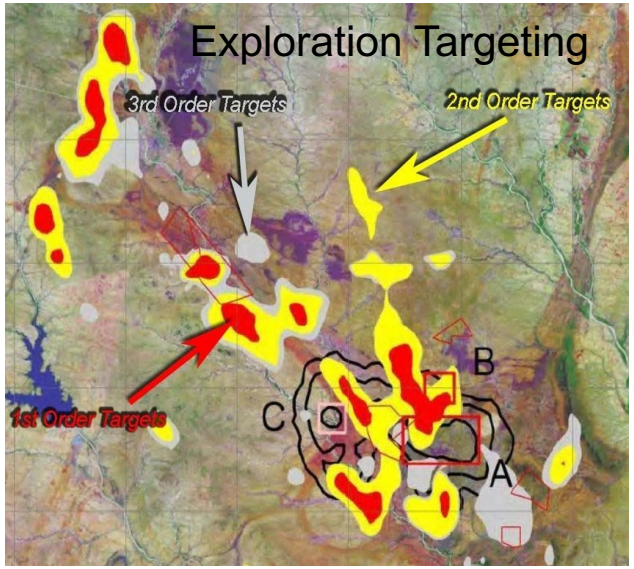
Understanding Formation



Distribution and Grade



Exploration Targeting



Future Discoveries

Mining Operations

Could GGM be applied to the Moon?

Genetic geological models can be effectively applied to lunar resources

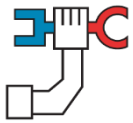
Ti-rich deposits

Selection rationale

Observational Evidence

Data available

Geological Knowledge

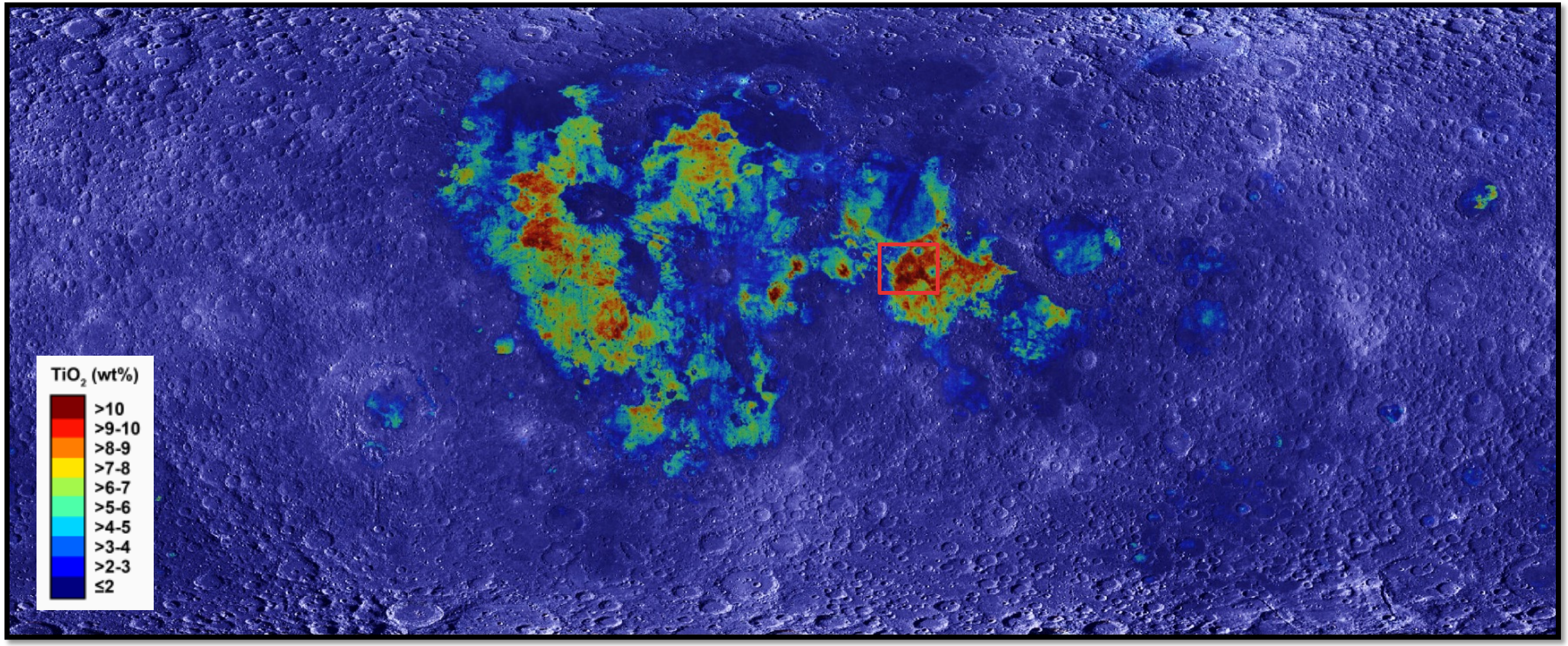


Current research at ESRIC

Hydrogen Reduction of Ilmenite for the Production of Oxygen and Metals from Lunar Regolith: Current Research at ESRIC, Dennis Harries (Thursday @ 1:15pm)

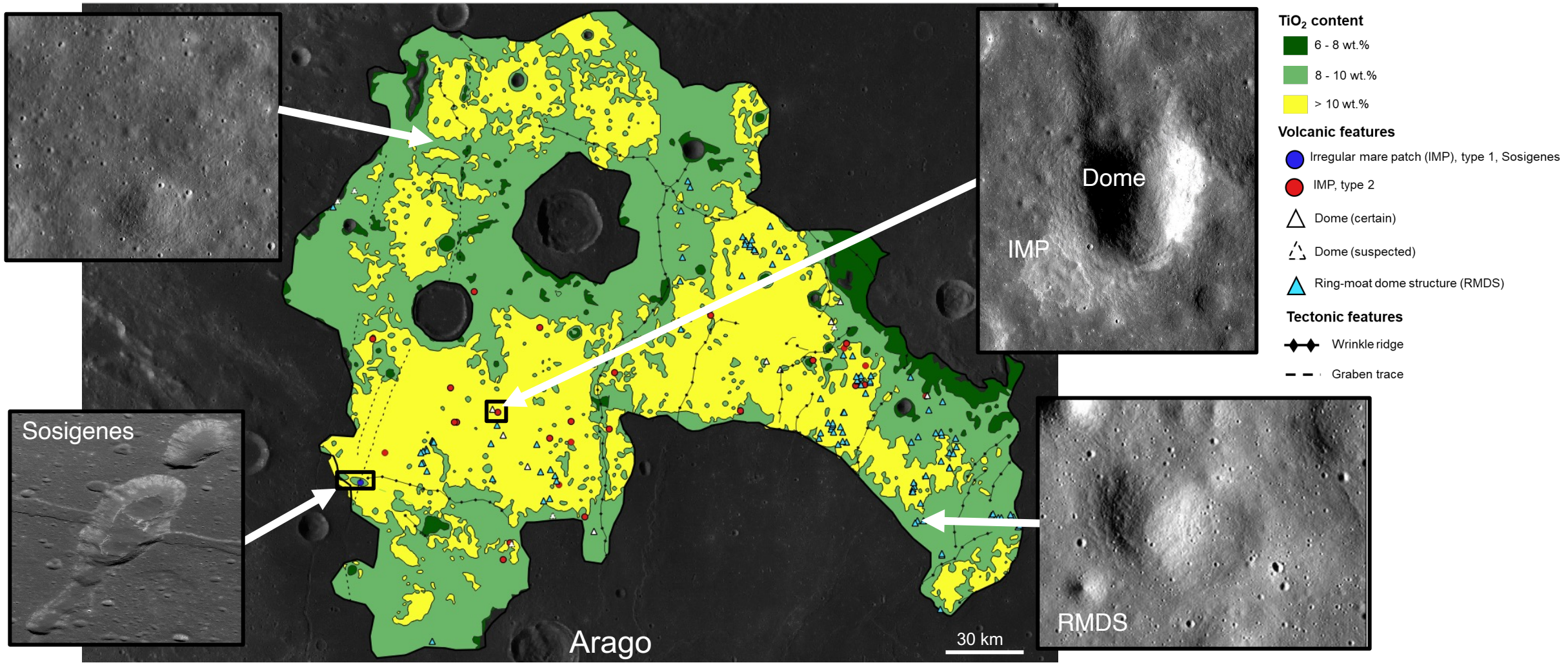
Ti-rich deposits

TiO_2 distribution



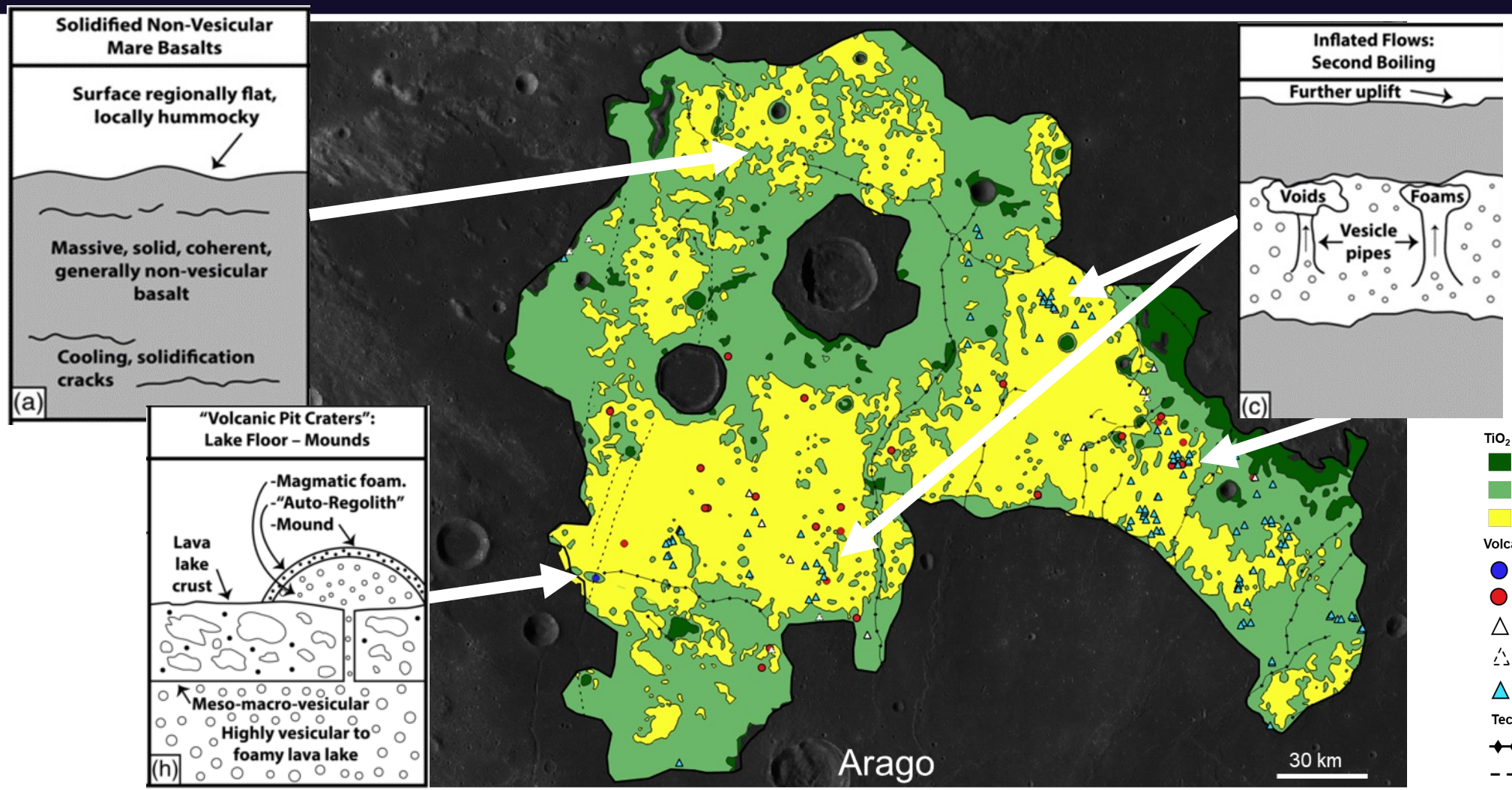
West Tranquillitatis

Volcanic features



Predicted regolith protoliths

Imbrian late-stage flow inflation with second boiling (Wilson & Head, 2017; Qiao et al. 2018)

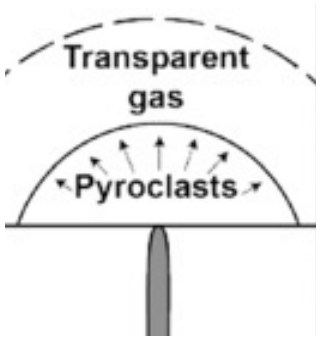


Small volume dike: IMP
Large volume dike: RMDS

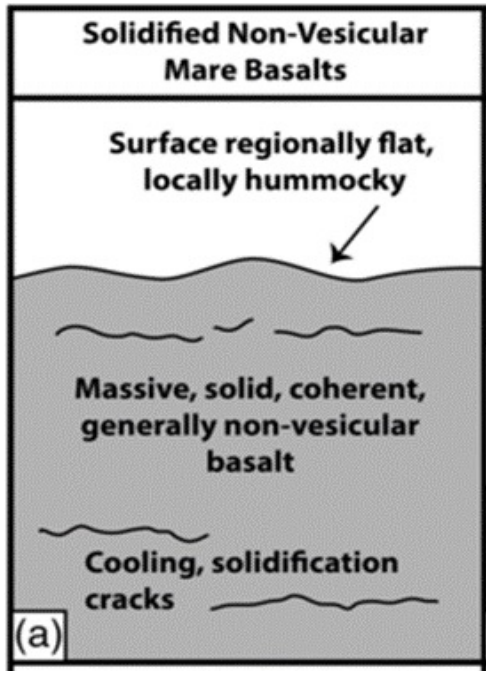
Volcanism

Stages of a lunar eruption

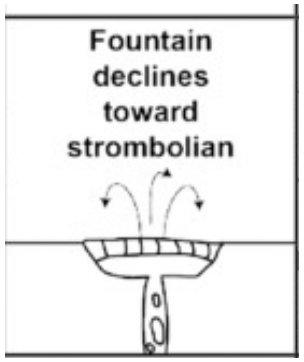
Stage 1



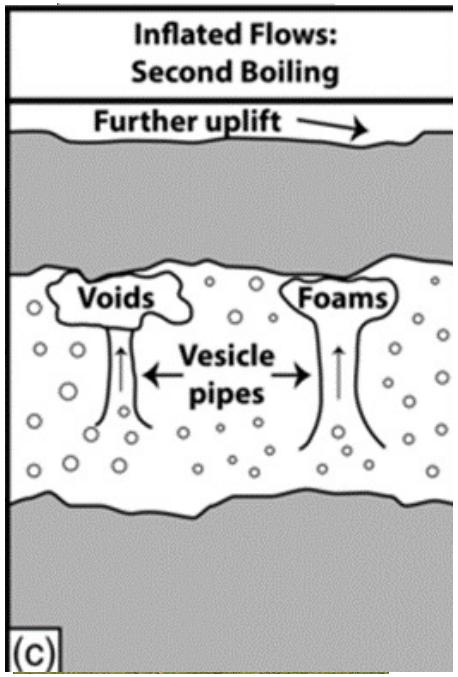
Stage 2



Stage 3



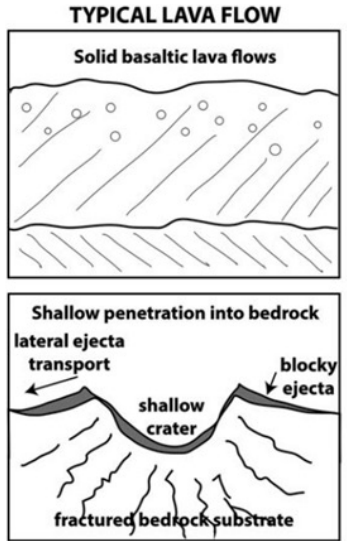
Stage 4



Application of protolith concepts to regolith formation

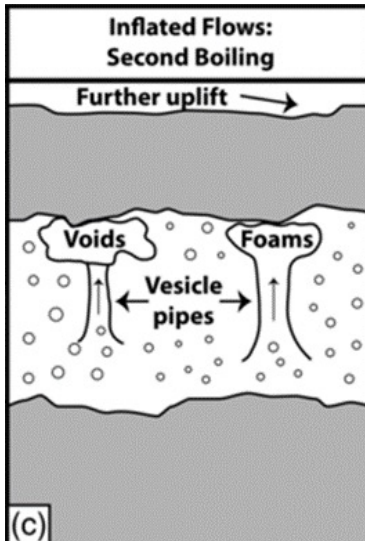
And what's next

- Initial topography (with variations up to tens of meters) influences deposit thickness and lateral continuity.
- Initial proportion of components determines grain properties (vesicularity, sizes, shapes, etc.) in evolving regolith.
- Different substrate responses to impact affects grain sizes, shapes, % agglutinates, abundances of rocks and thickness.



Typical mare regolith

Formation of fragmented ejecta layers, optical maturity because accumulation of impact-melt-welded agglutinates, and degradation of boulders by micrometeorites

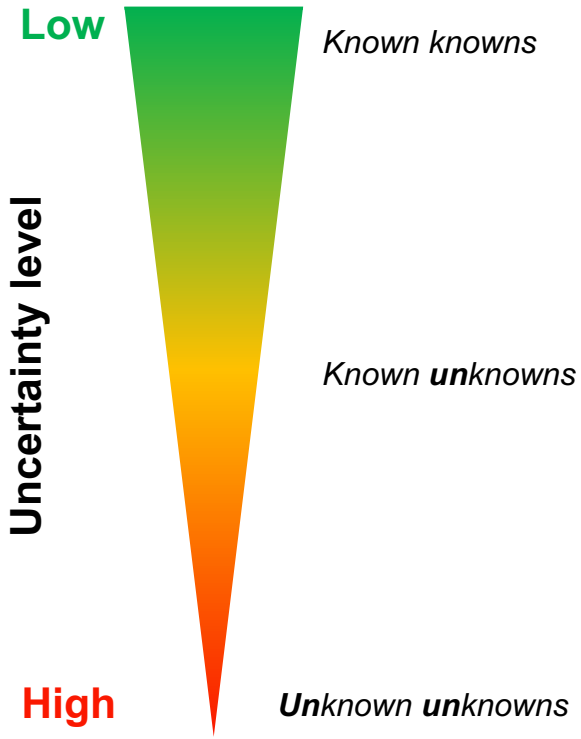


Initially fined grained material, impact-induced crushing of vesicles and voids, and potential slowing of maturation due to drainage of the finest fraction into the still porous substrate

(Head and Wilson, 2020)

Concluding remarks

Dealing with the unknown

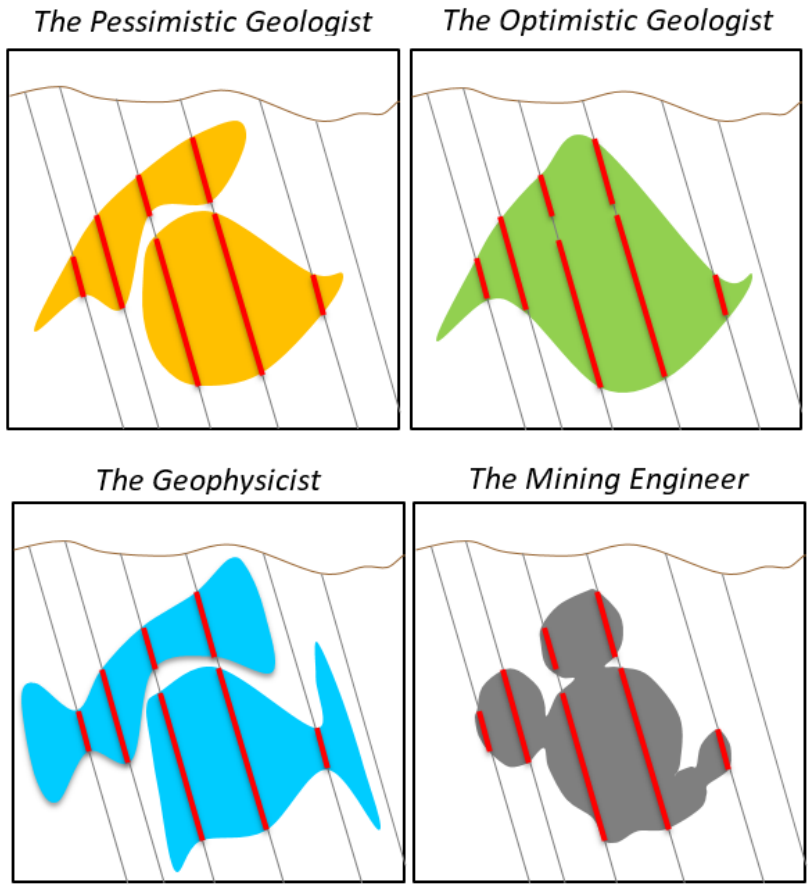


Presence on the Moon
Detected in significant abundances
Ilmenite composition well documented through analyses of lunar samples
Origin tied to volcanic activity and differentiation of lunar magma

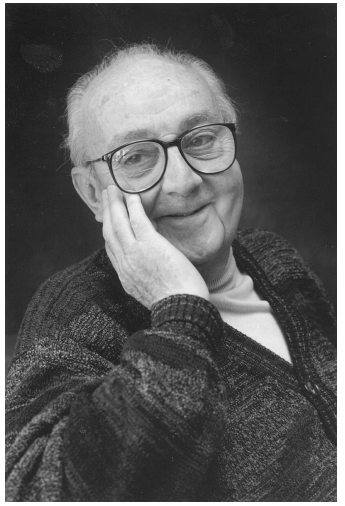
Detailed mapping of distribution and variability of deposit
Origin of the parent magma and geological controls
Regolith layer development and geotechnical properties

Unanticipated geological processes
Unexpected spatial patterns
Unknown ilmenite variants

Thank you!



"All models are wrong but some are useful"



George E. P. Box (1919-2013)