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THE DISTRIBUTION OF VOLCANISM ON VENUS

and global tectonic implications

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RESEARCH OBJECTIVES

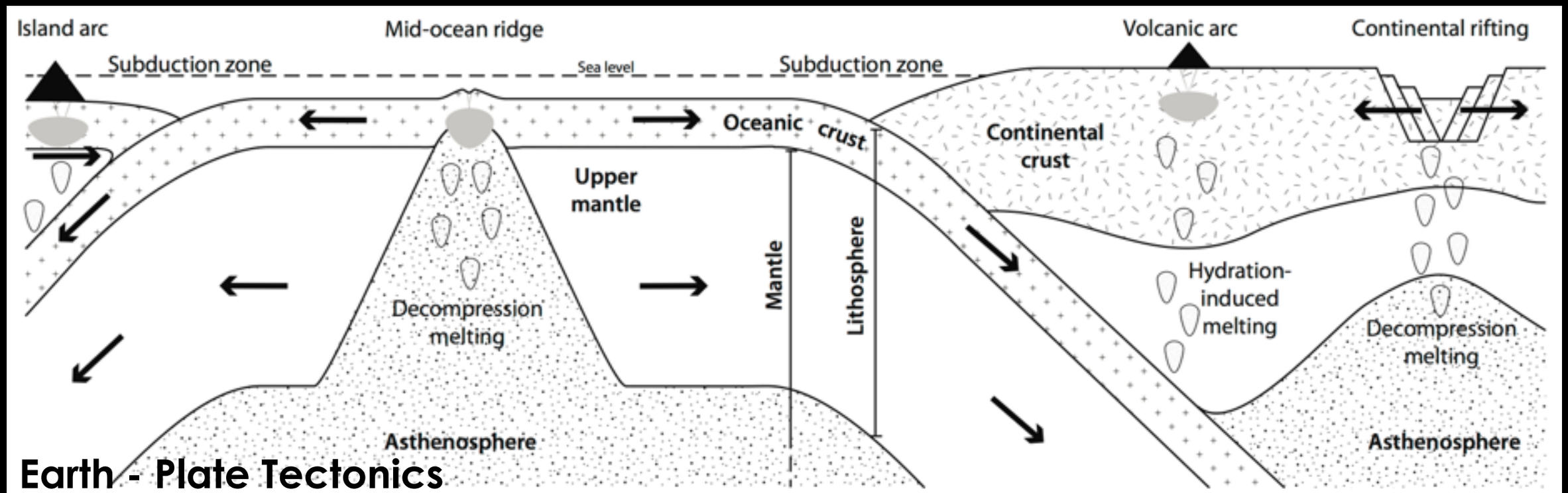
Identify:

- Signifiant patterns/trends in volcanic features' **distribution**
- **Association** of volcanoes with **rifts**
- Significant **temporal/stratigraphical** relationships

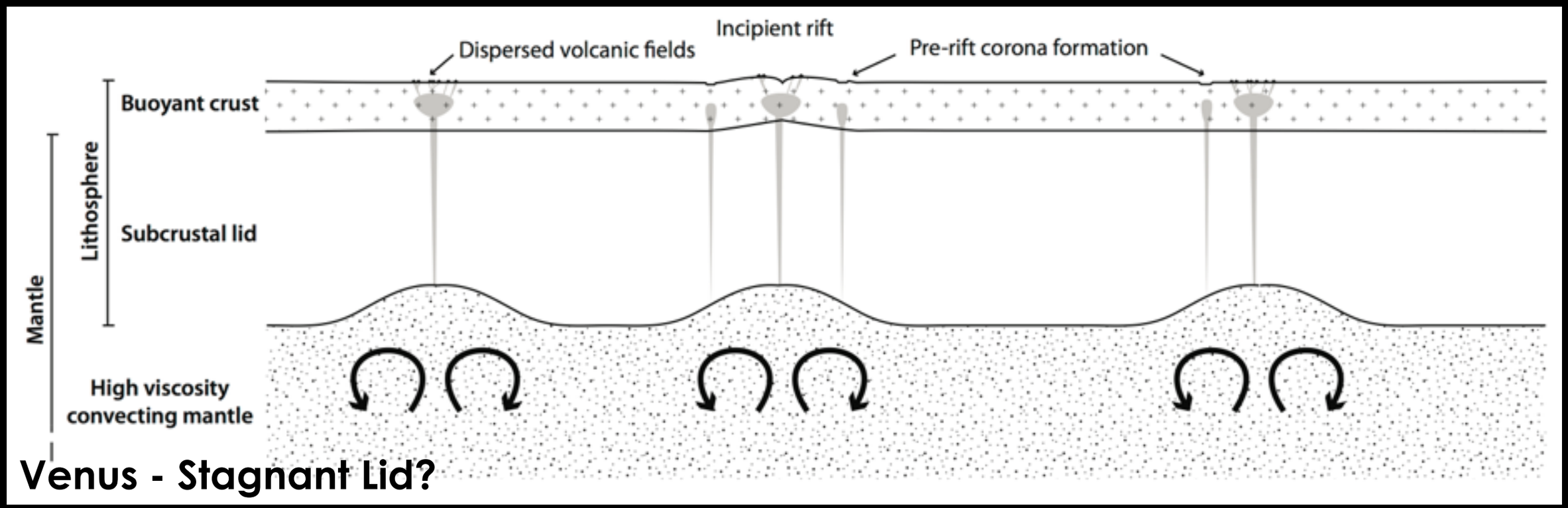
Interpret:

- Internal driving **volcano-tectonic processes**
- Nature of **geological evolution** of Venus' surface

Tectonics of Venus and Earth

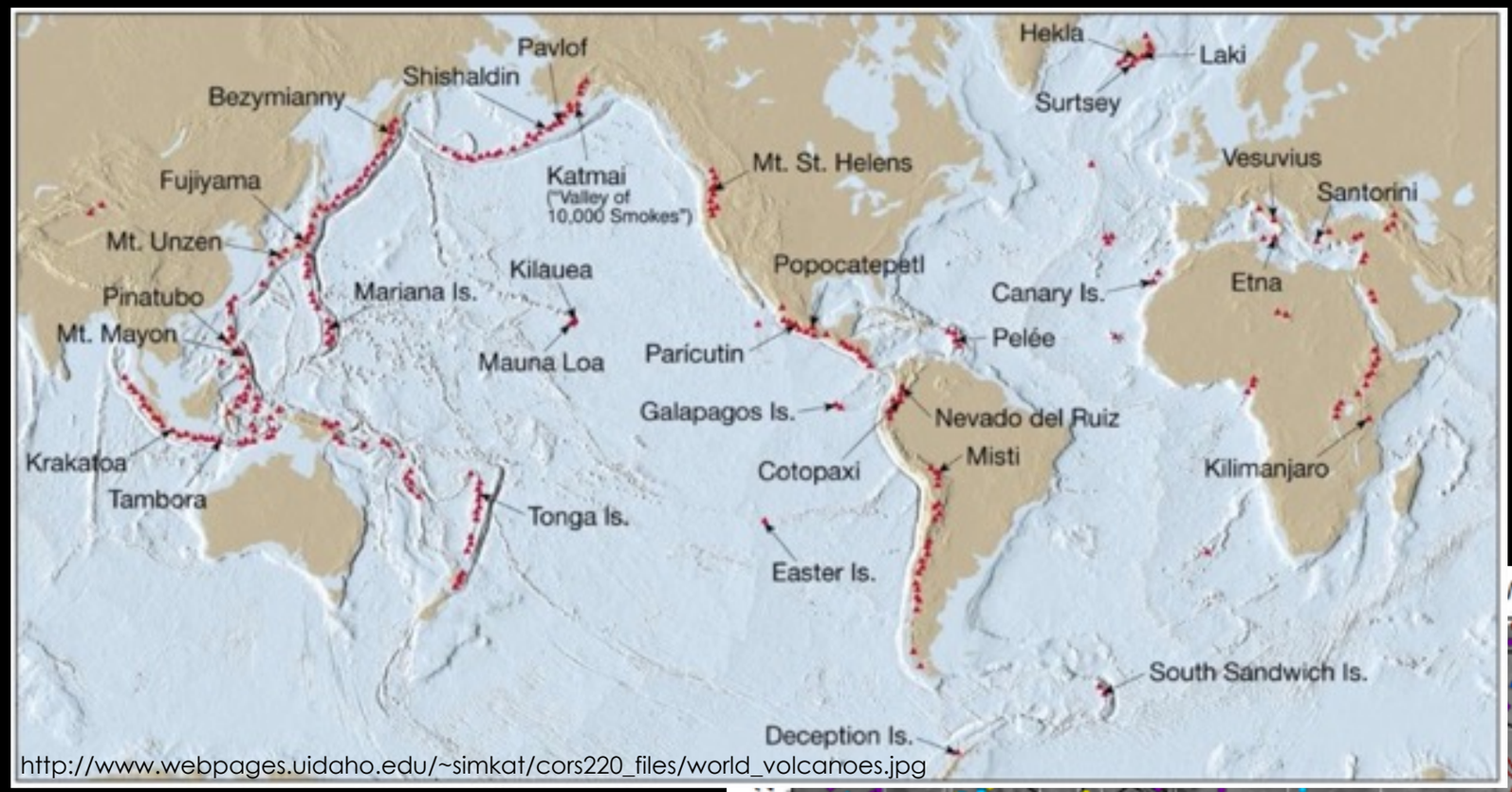


Earth - Plate Tectonics



Venus - Stagnant Lid?

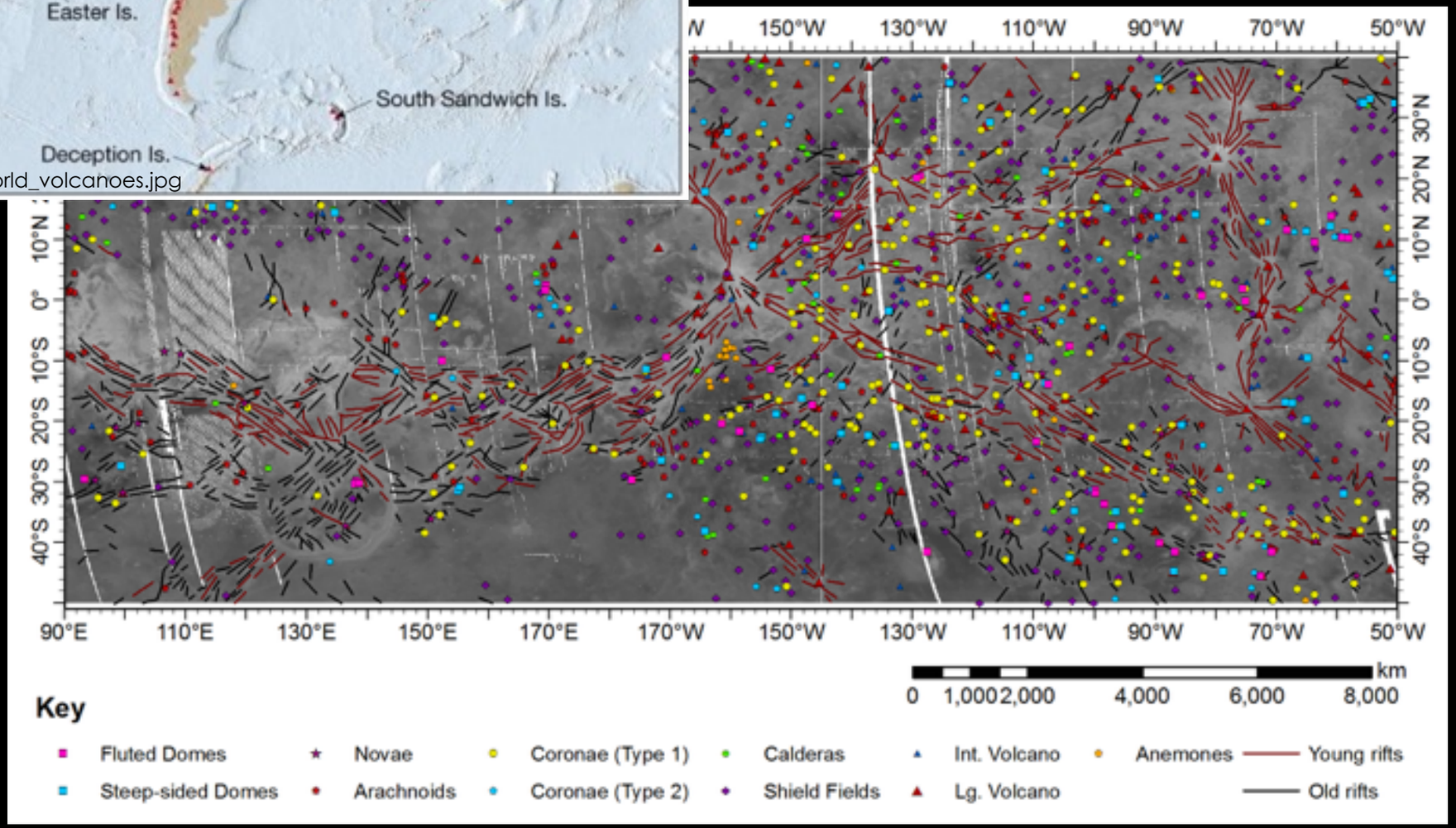
Tectonics of Venus and Earth



http://www.webpages.uidaho.edu/~simkat/cors220_files/world_volcanoes.jpg

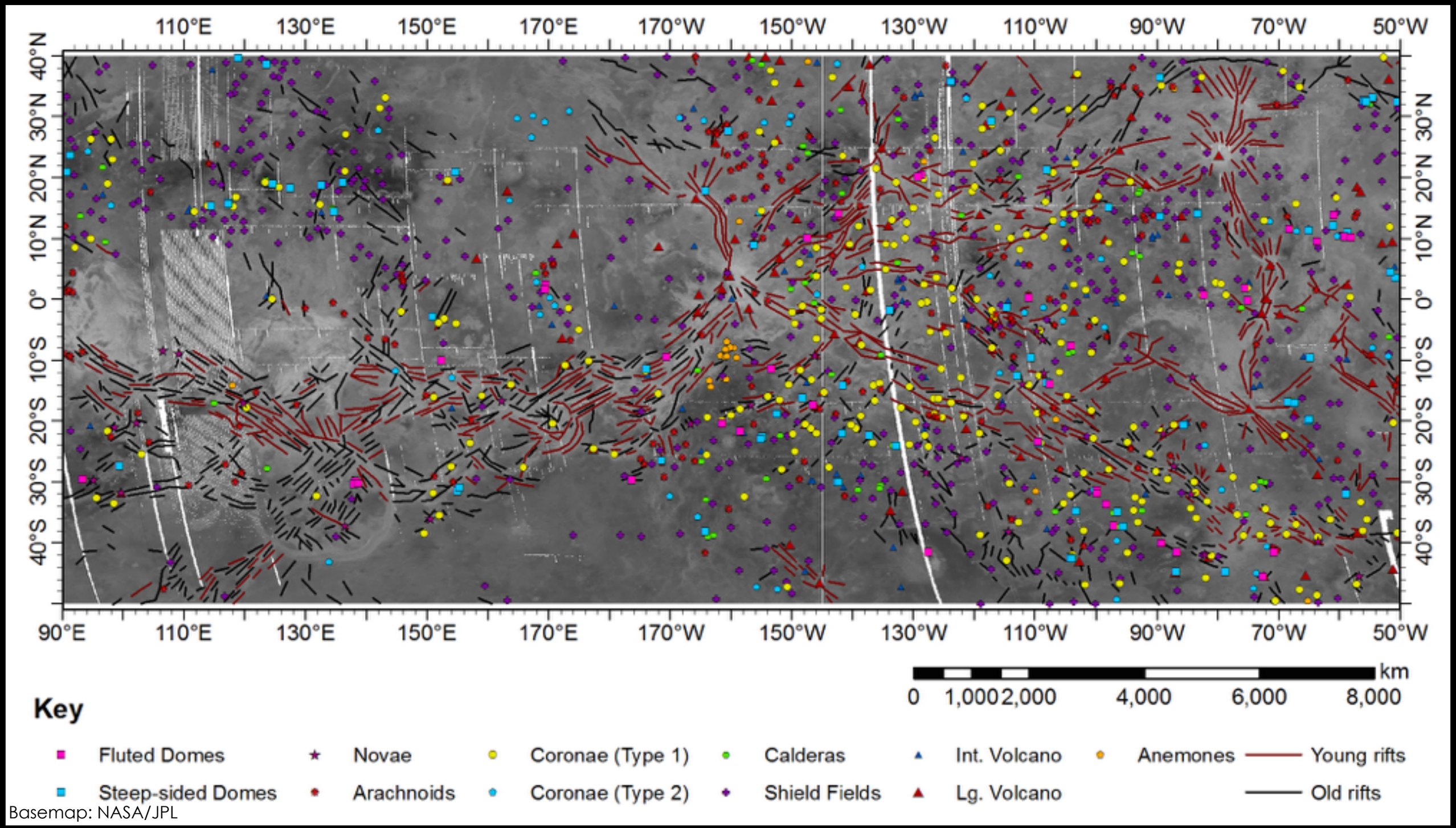
Earth - Volcanic features track plate boundaries

Venus - Widely distributed volcanism



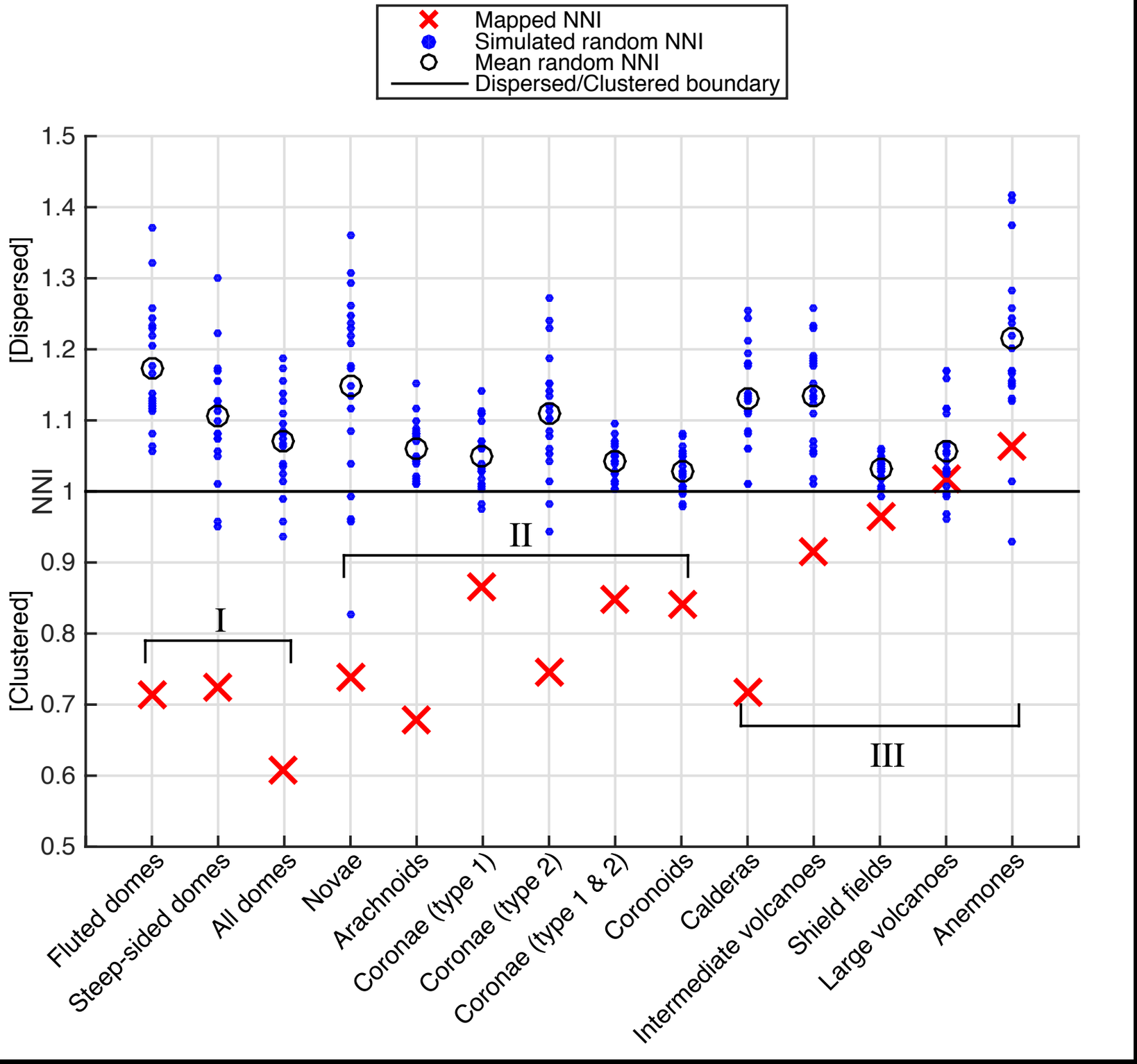
Data and Mapping

Data sources: **Volcanoes & Coronae** (Head et al., 1992; Crumpler and Aubele, 2000), **Rifts** (Krassilnikov et al., 2012), **Coronae** (Stofan et al., 2001)



Basemap: NASA/JPL

Spatial Relationships - Nearest Neighbour Index

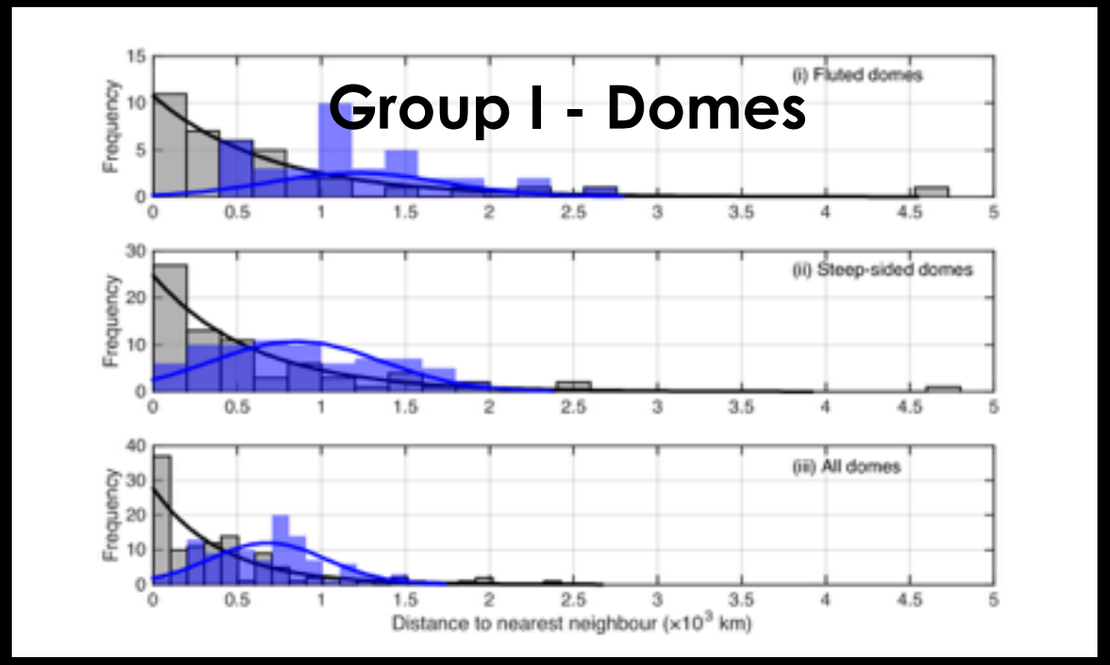


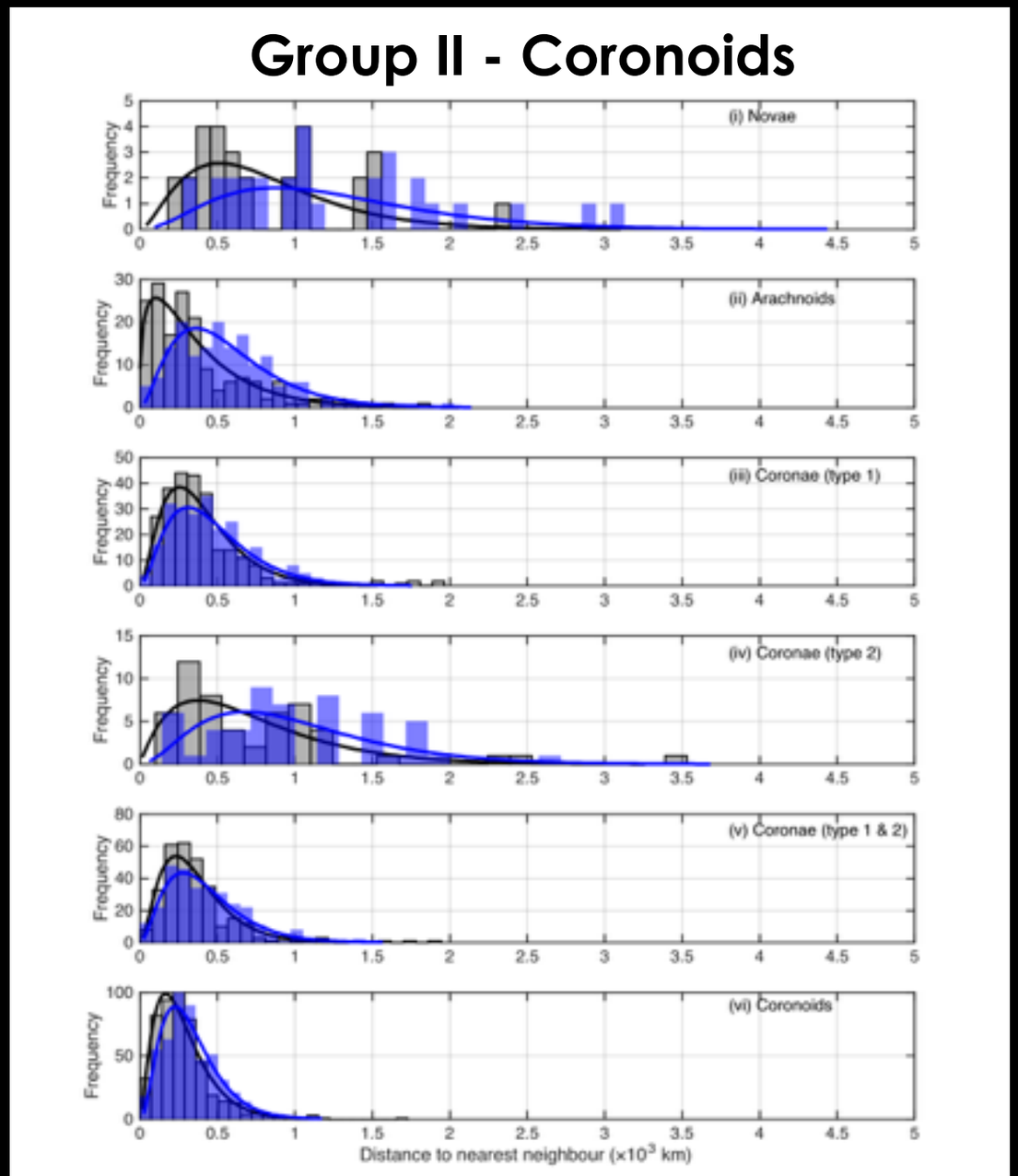
$$NNI = \frac{D_O}{D_E}$$

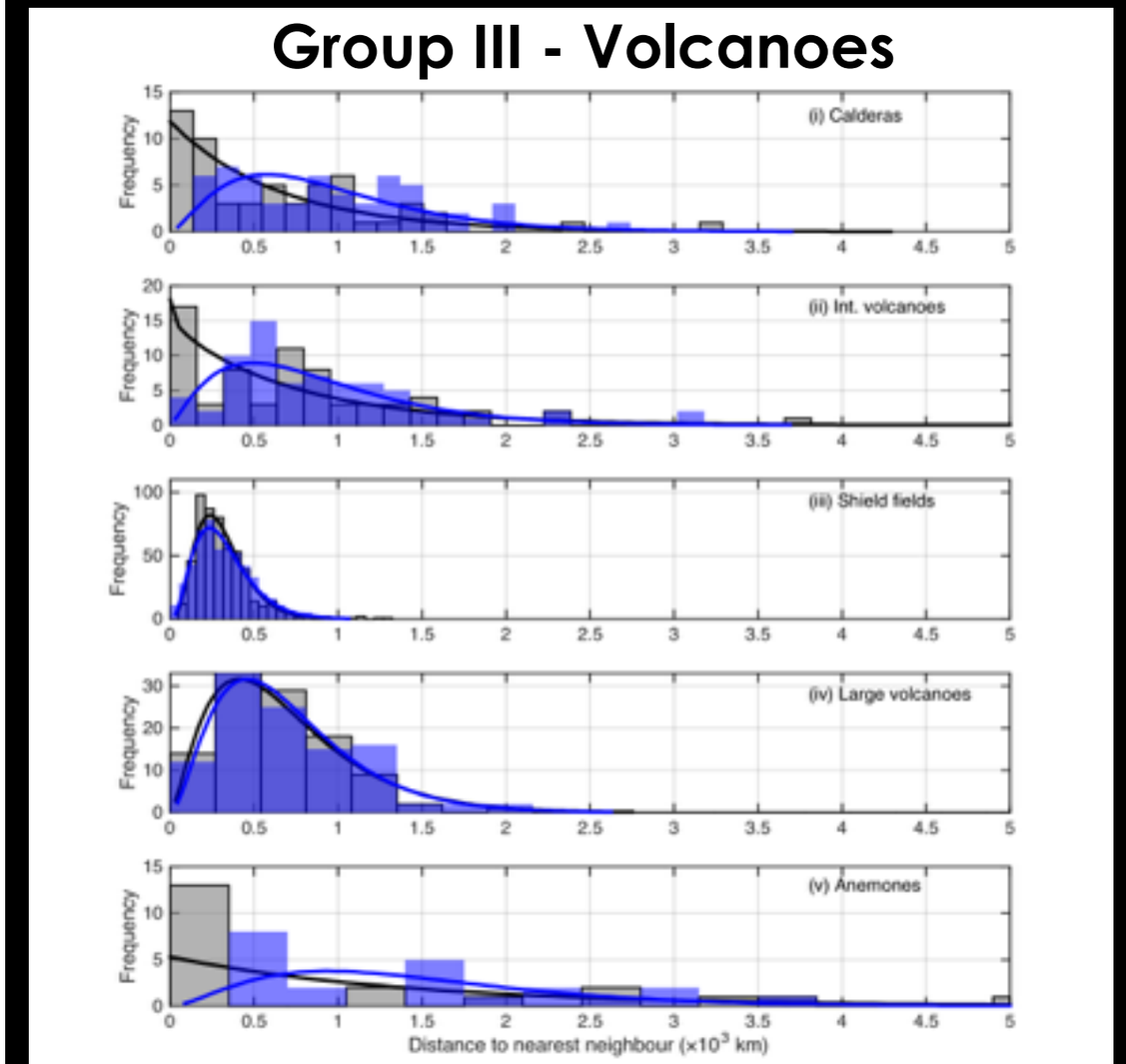
$$D_O = \frac{\sum_{i=1}^{n} d_i}{n}$$

$$D_E = \frac{0.5}{\sqrt{\frac{n}{A}}}$$

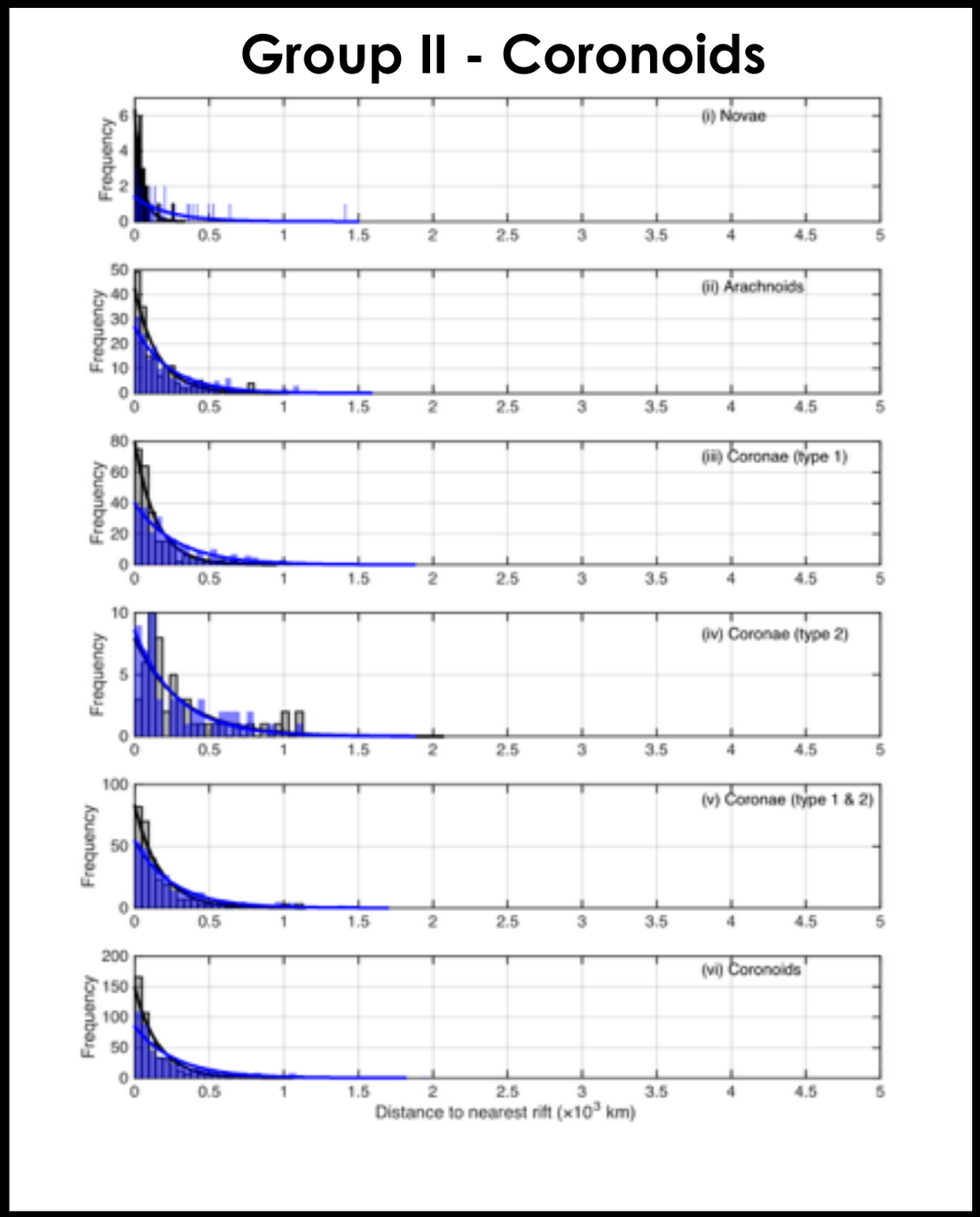
Distance to Nearest Neighbour

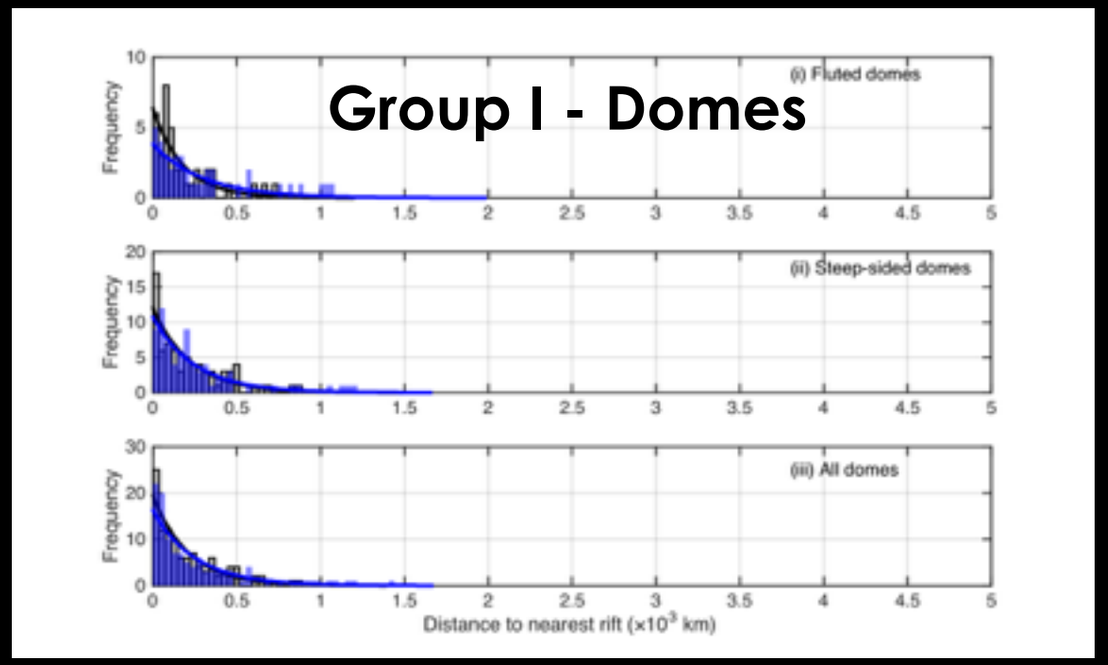


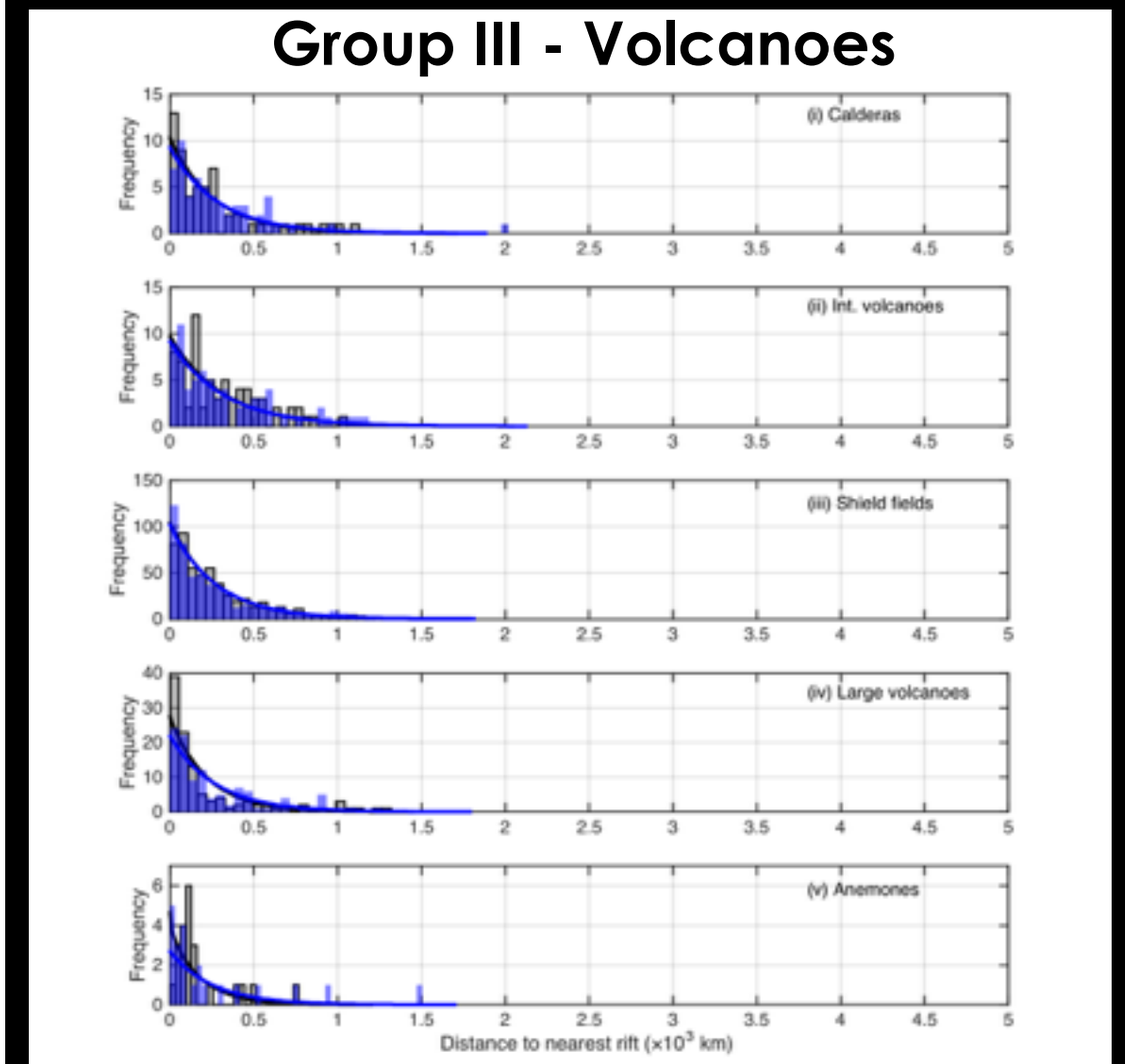




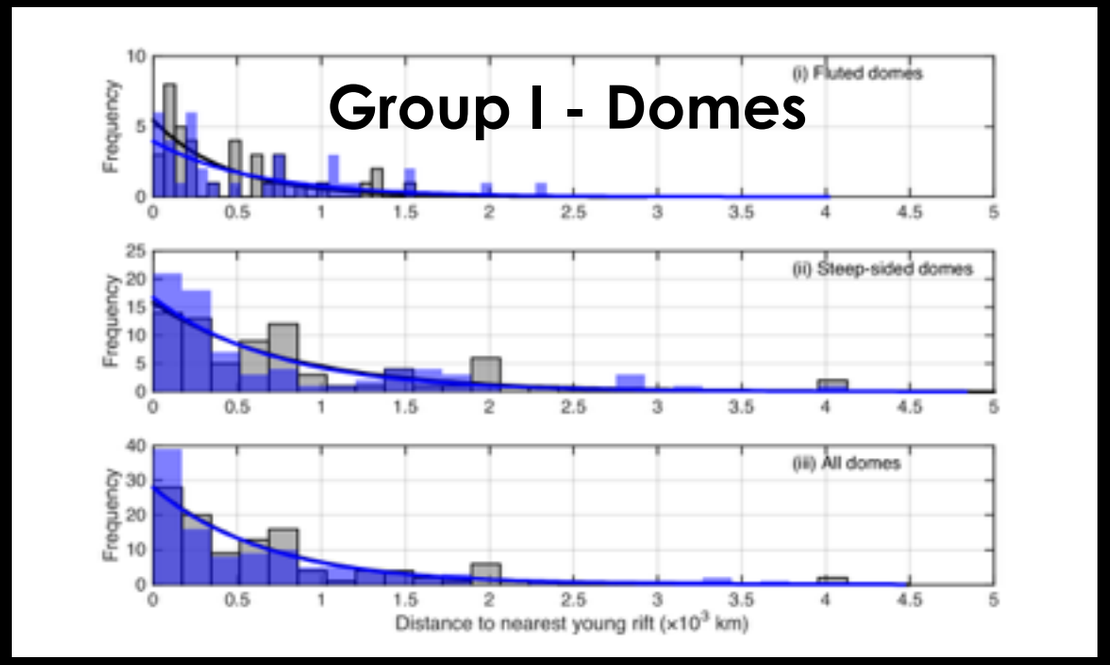
Distance to Nearest Rift

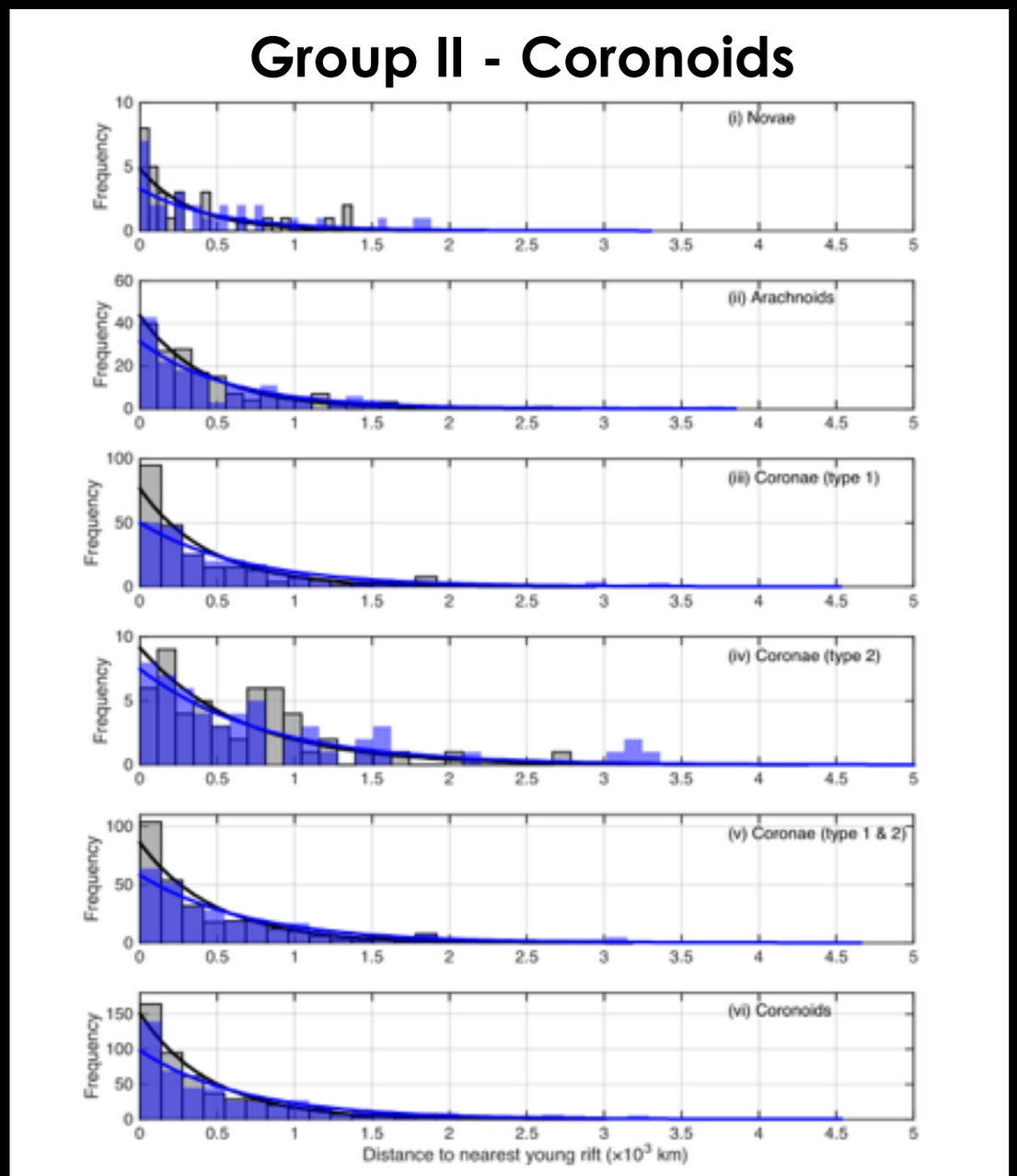


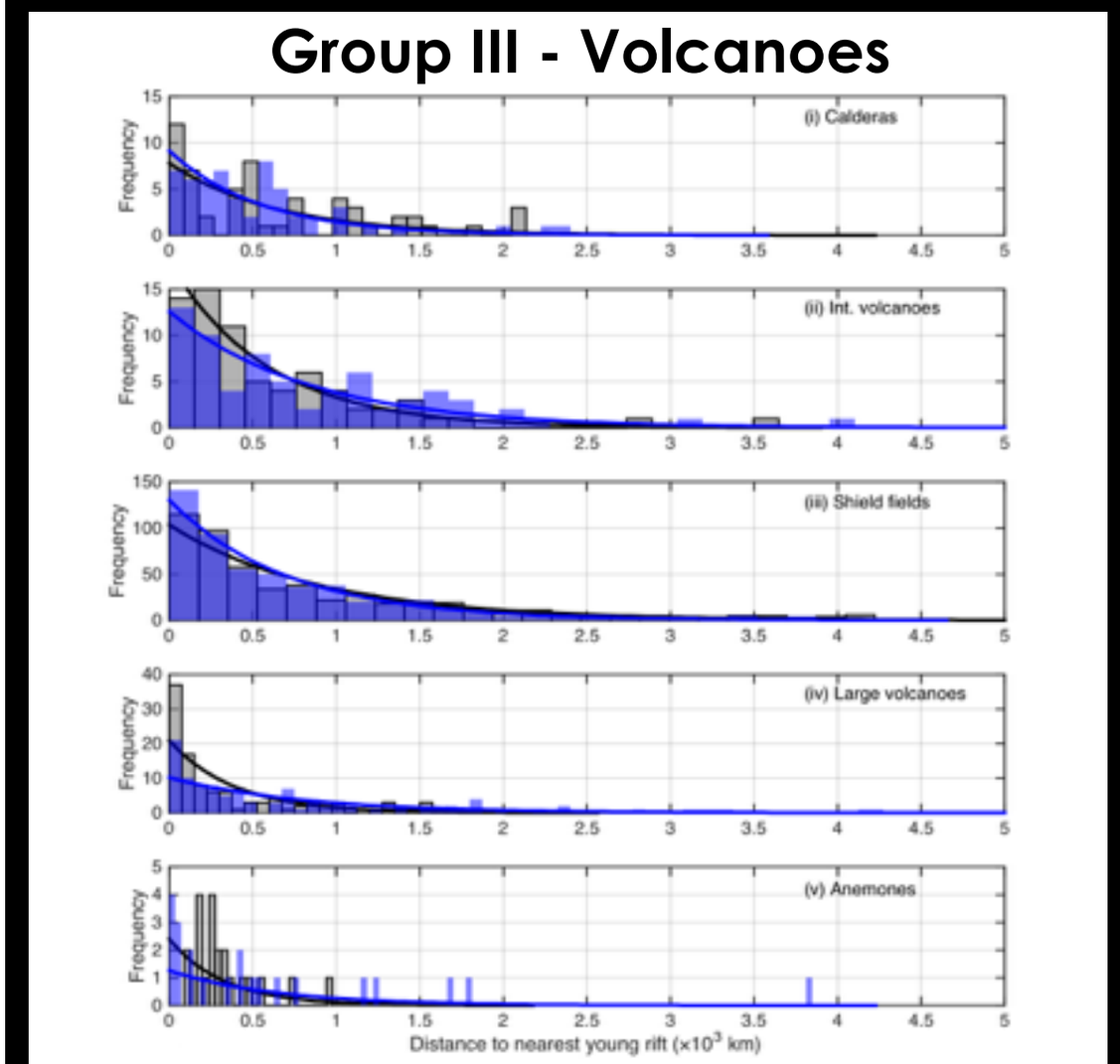




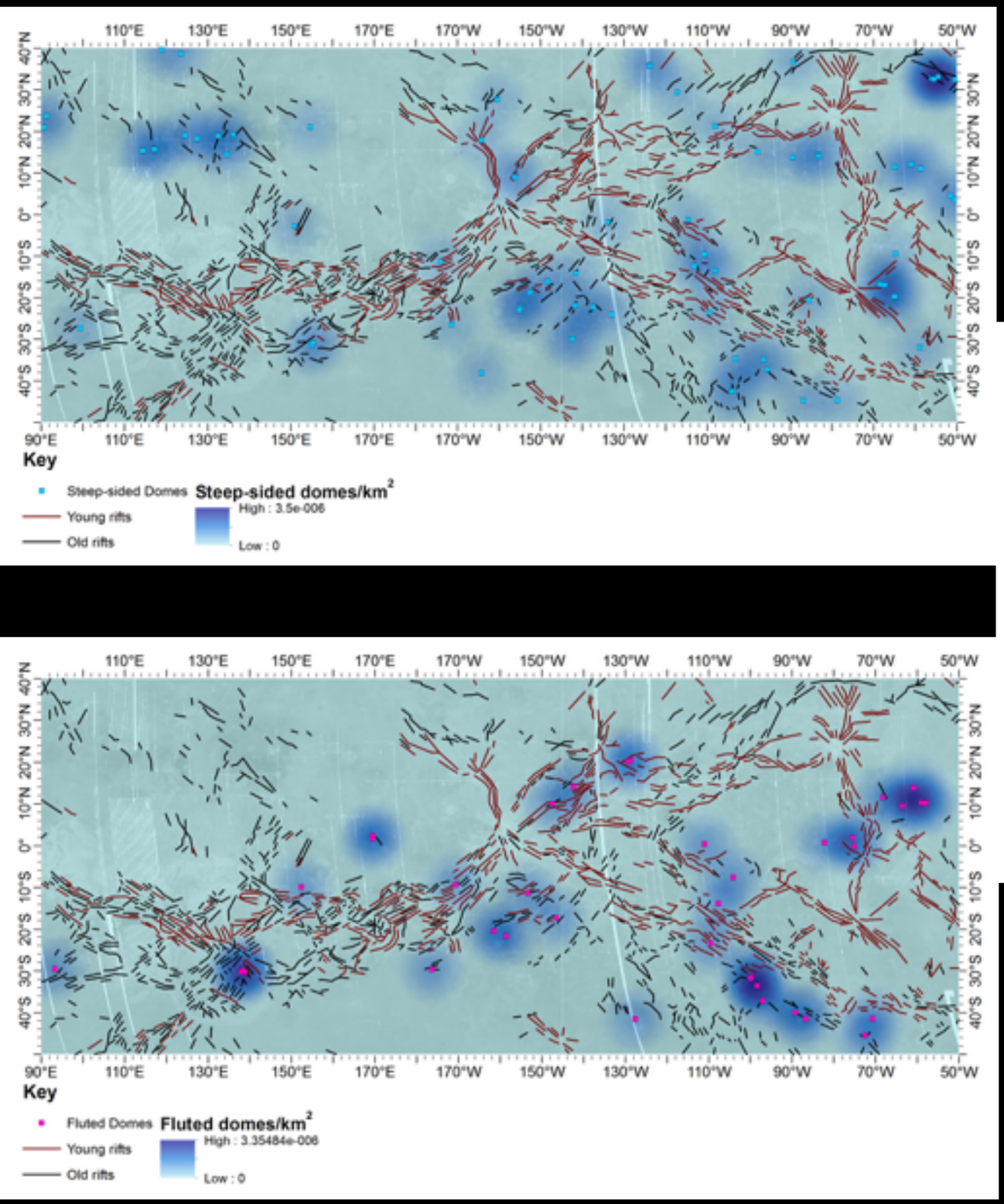
Distance to Nearest Young Rift

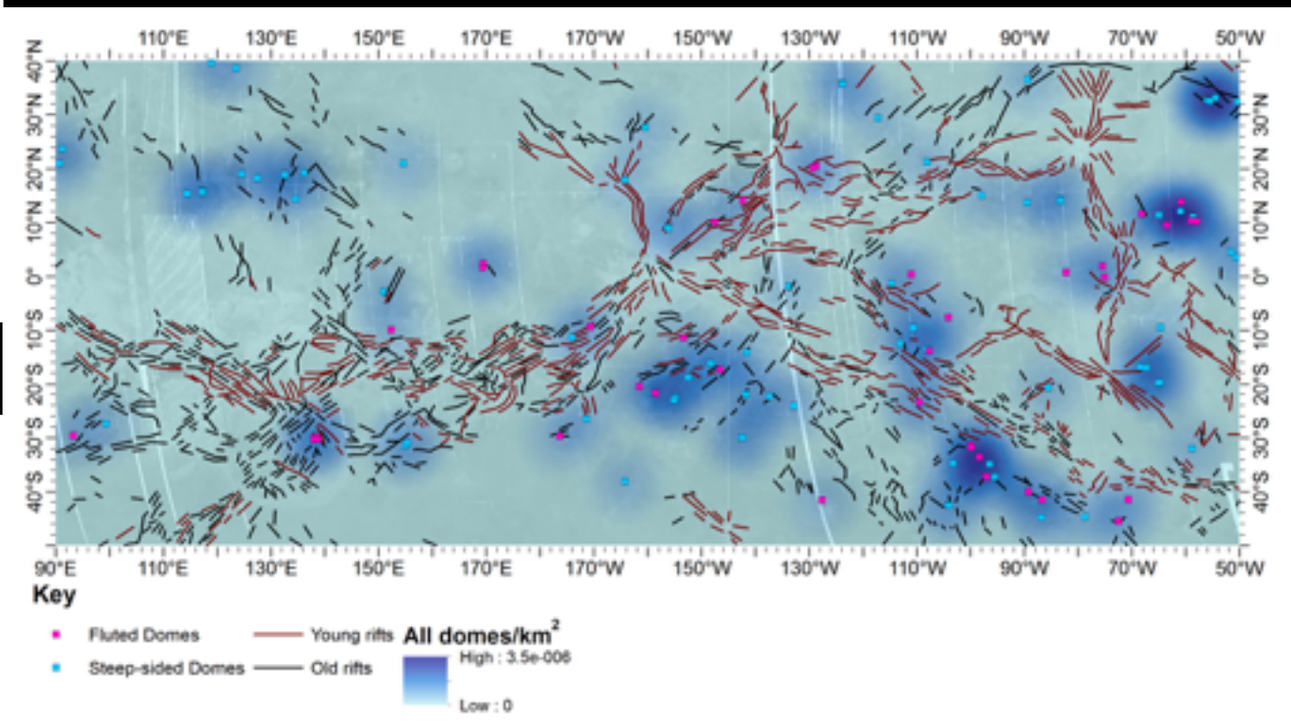




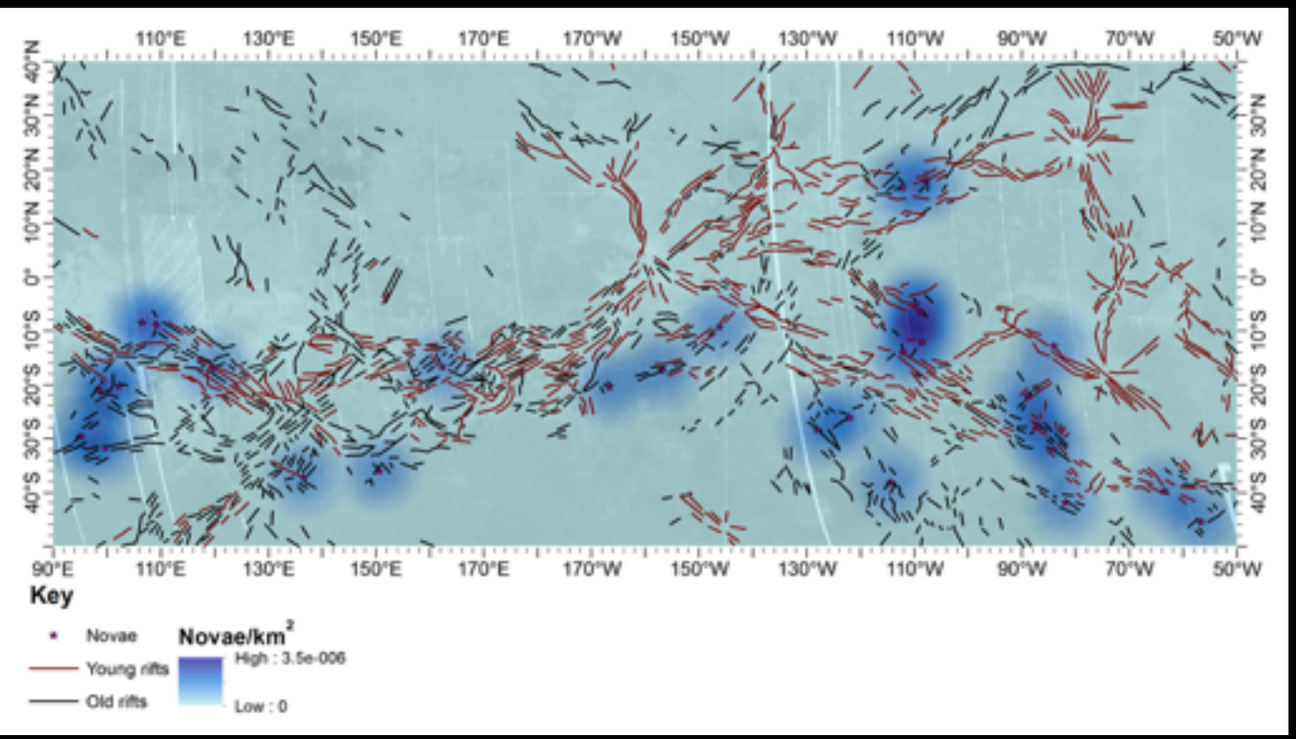


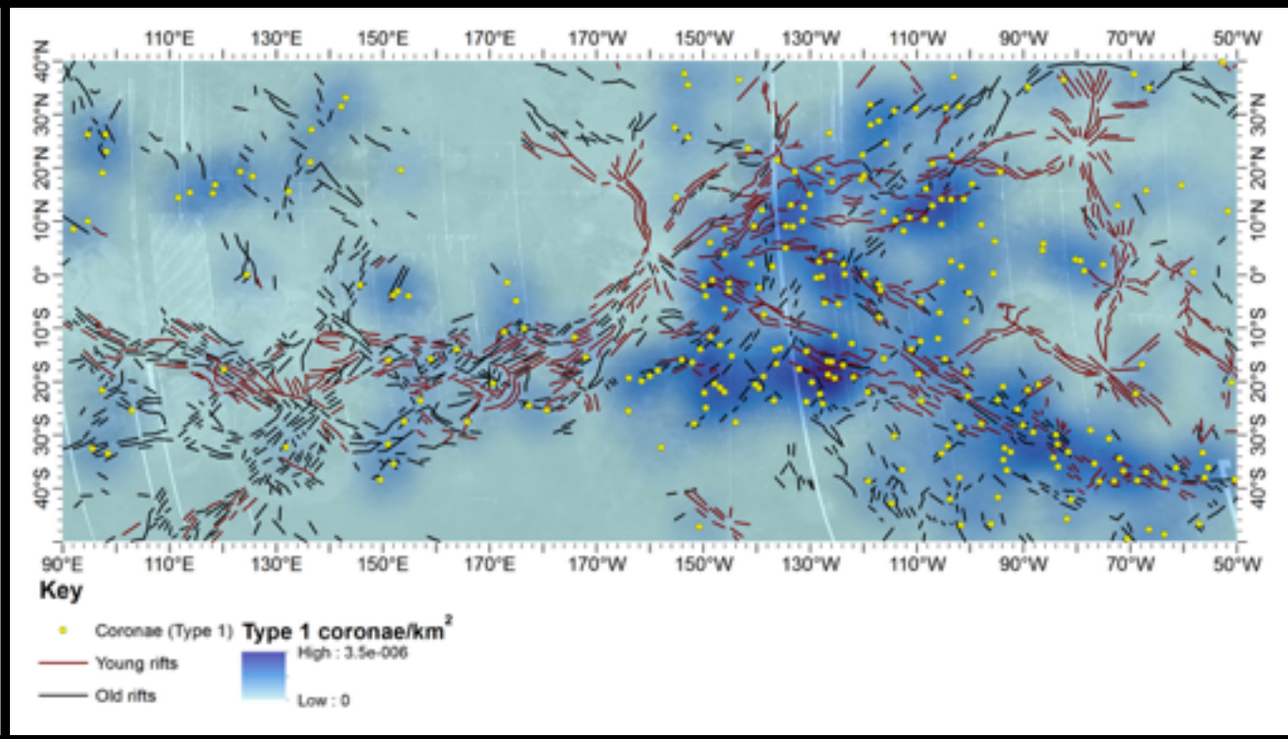
Feature Density - Group I

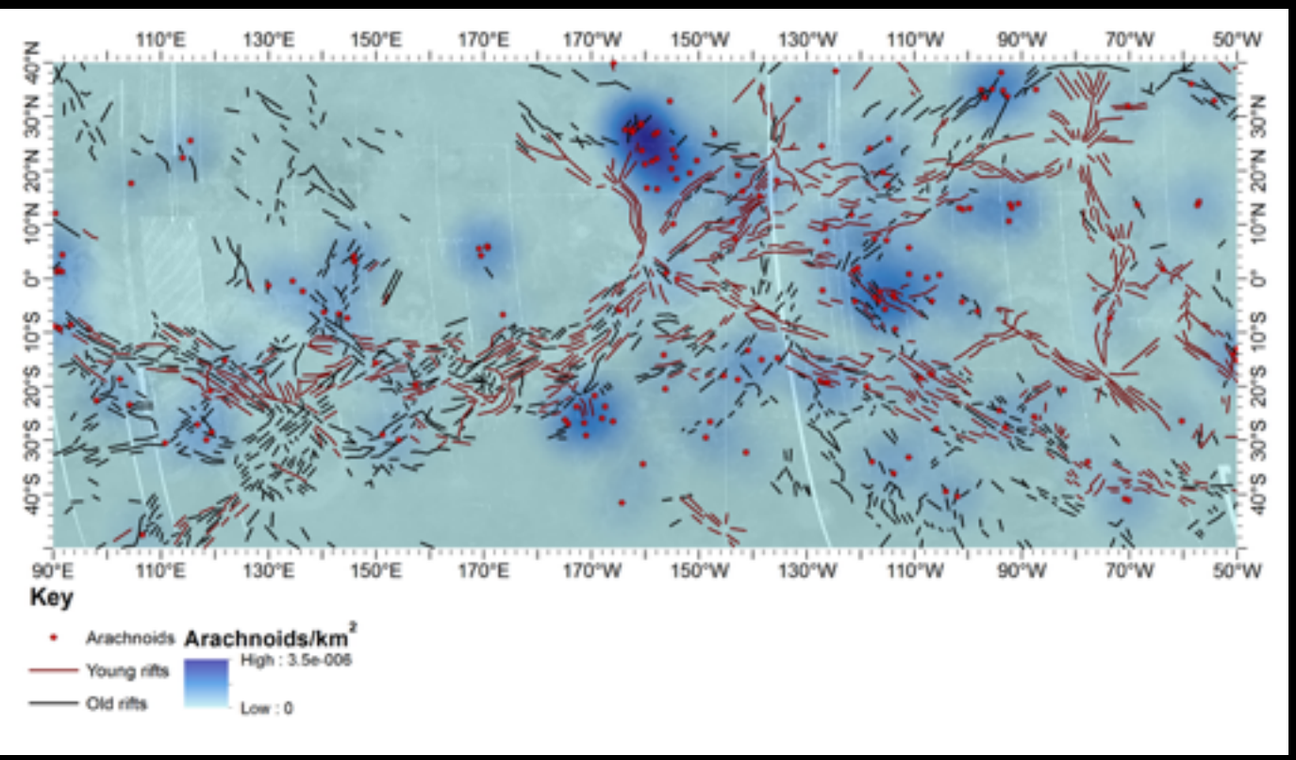


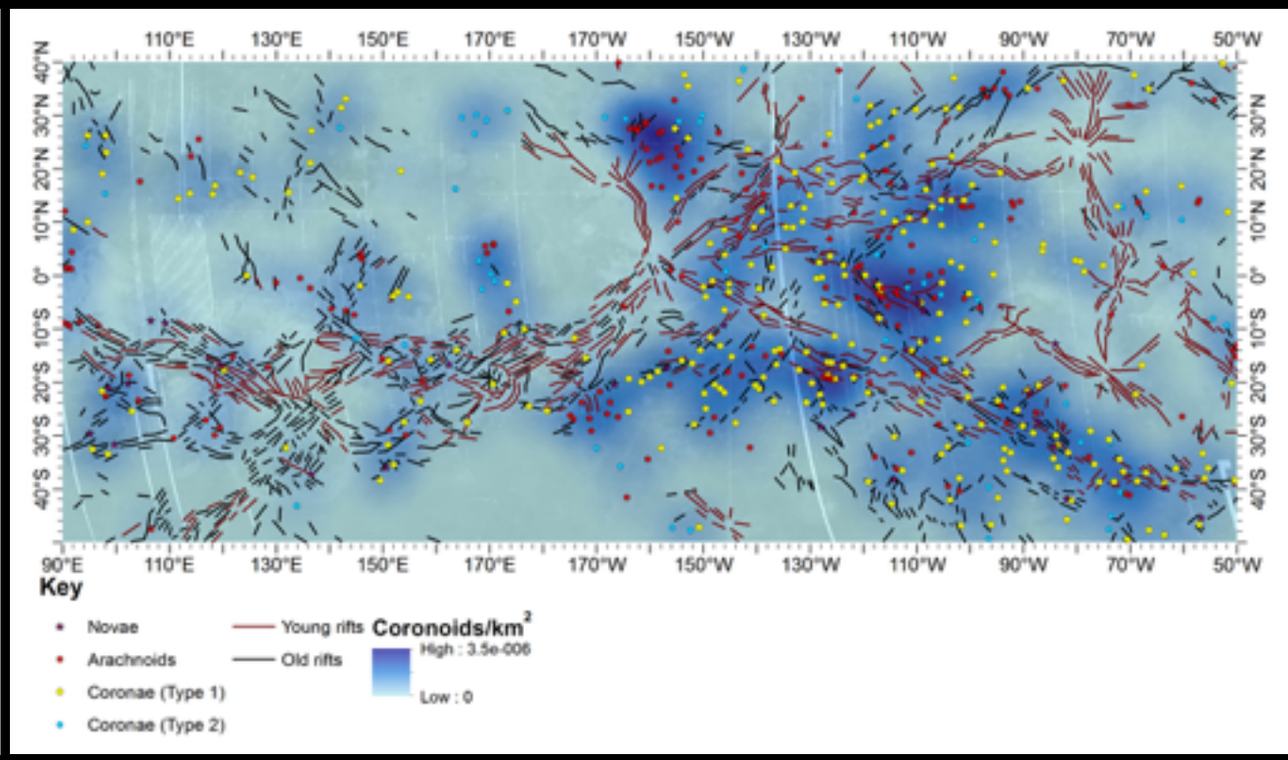


Feature Density - Group II

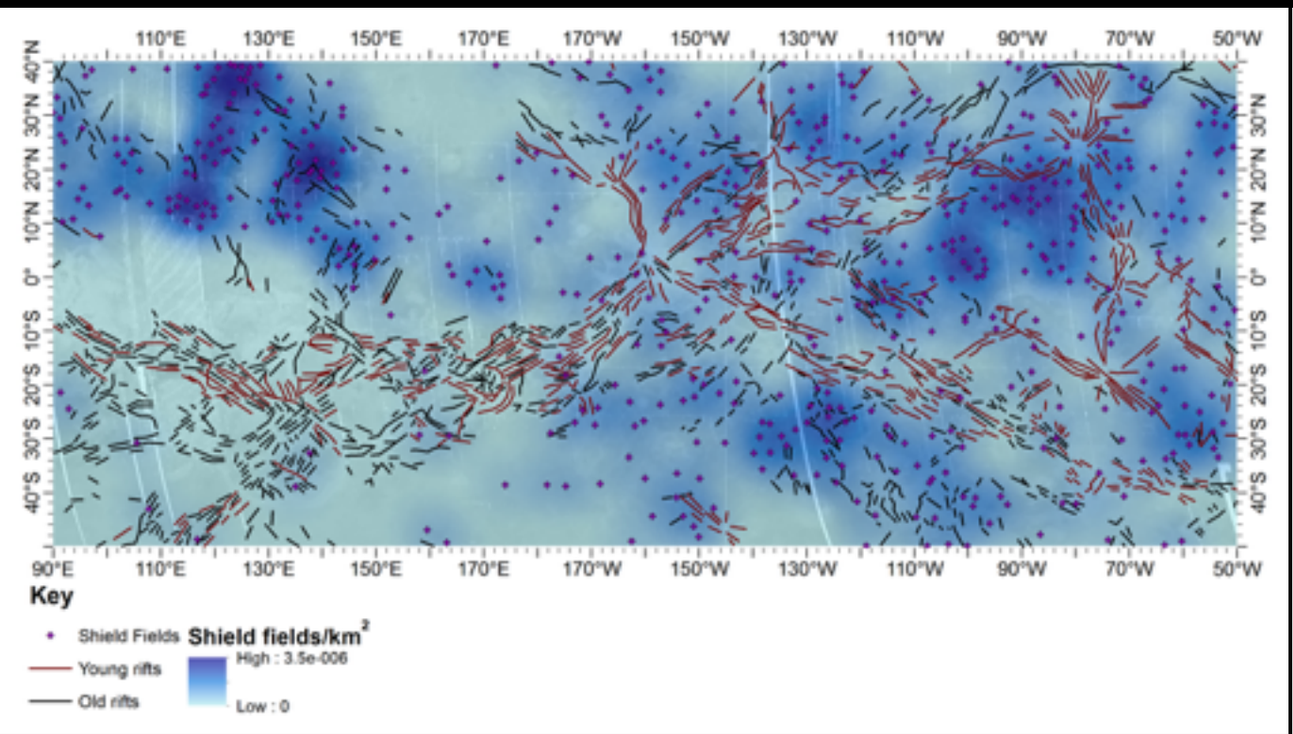


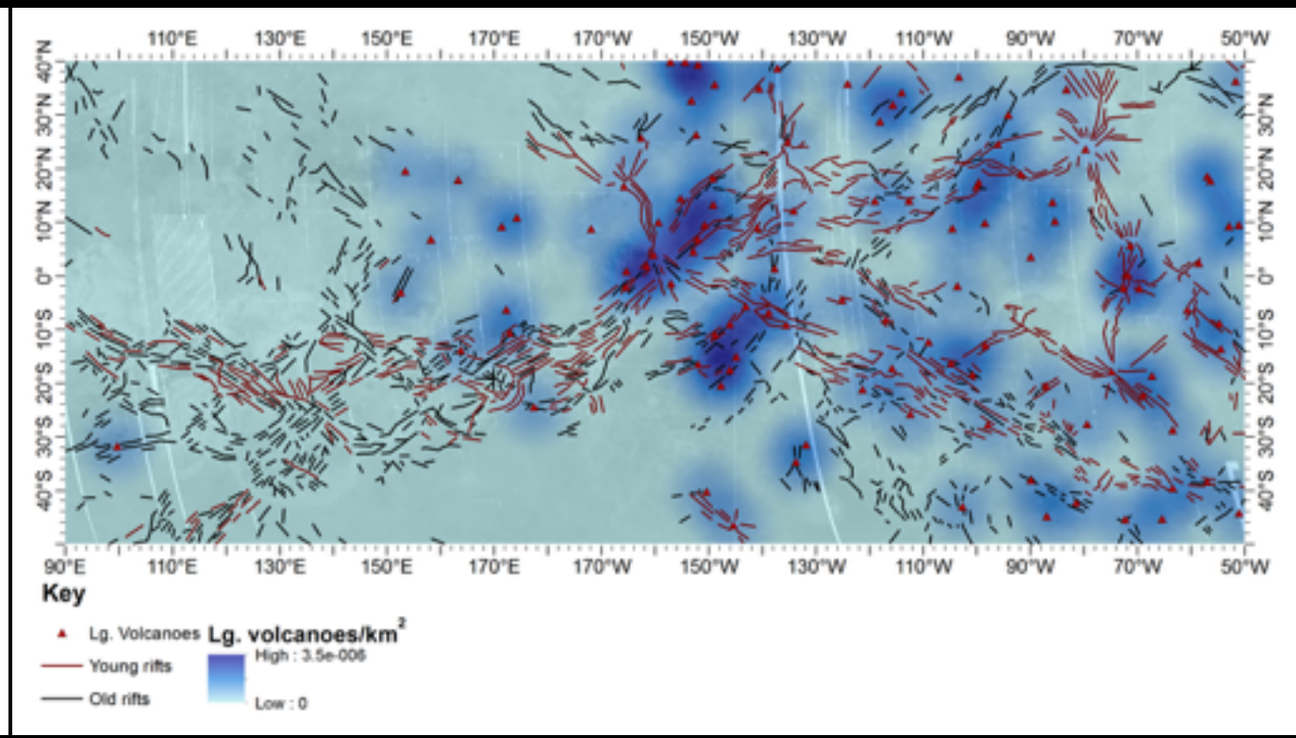


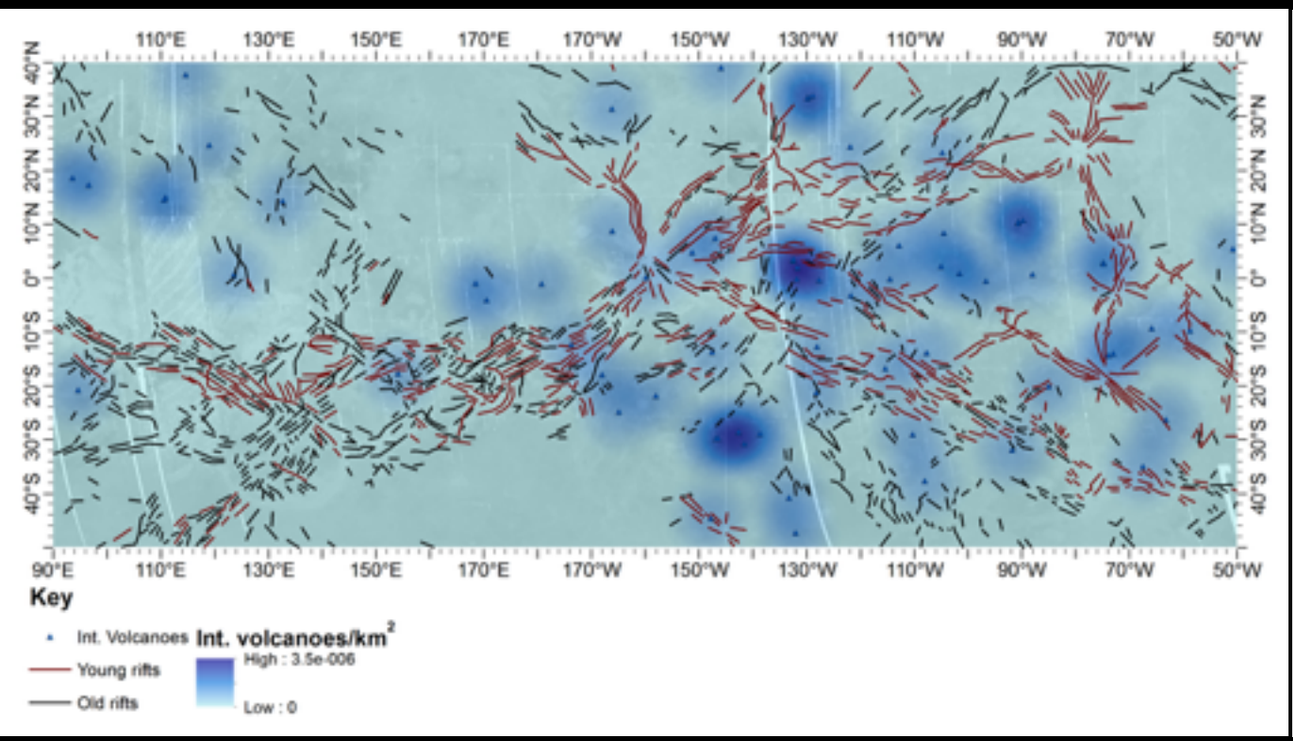


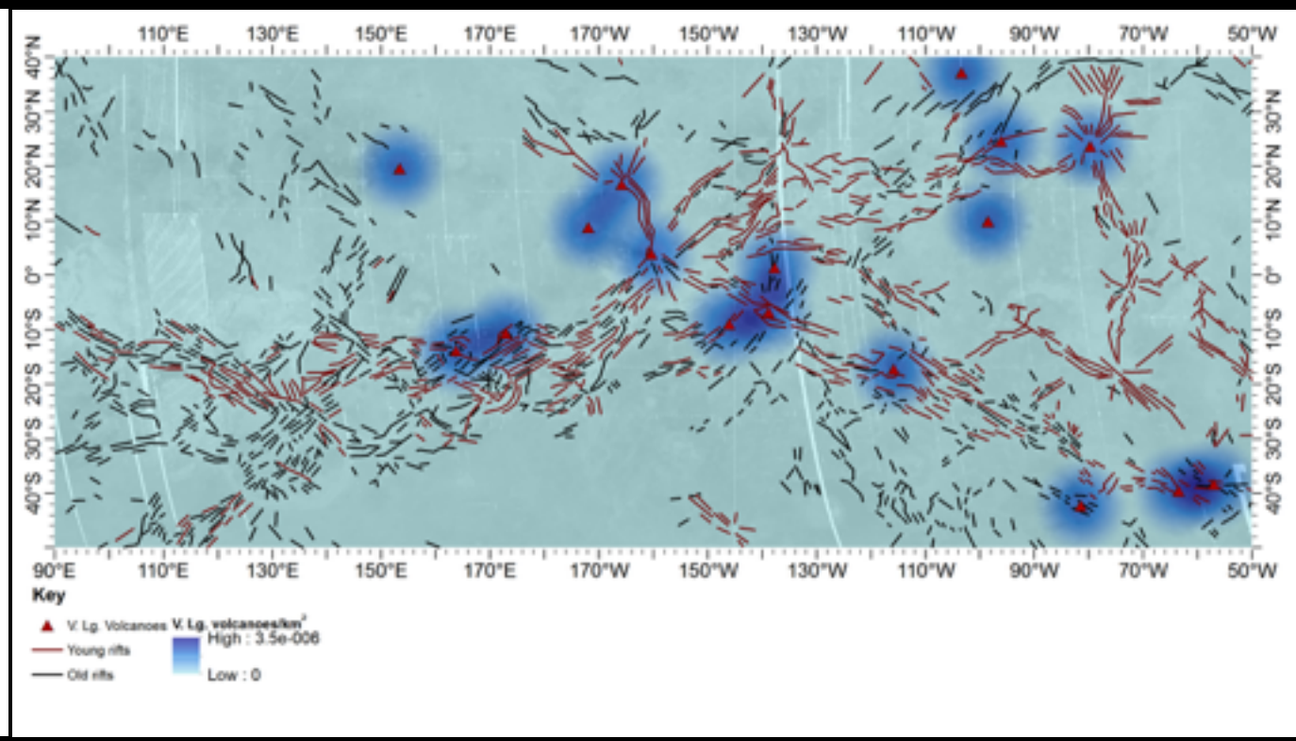


Feature Density - Group III









Spatial Relationships

Group I:

- Strong clustering
- Rift distance inconclusive

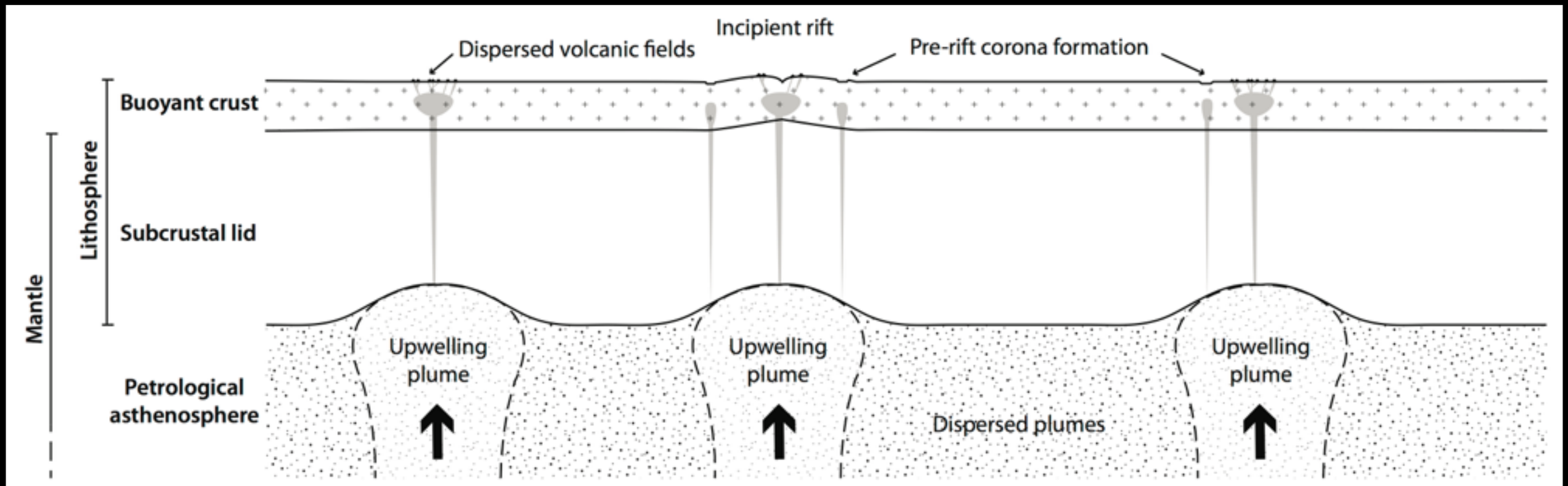
Group II:

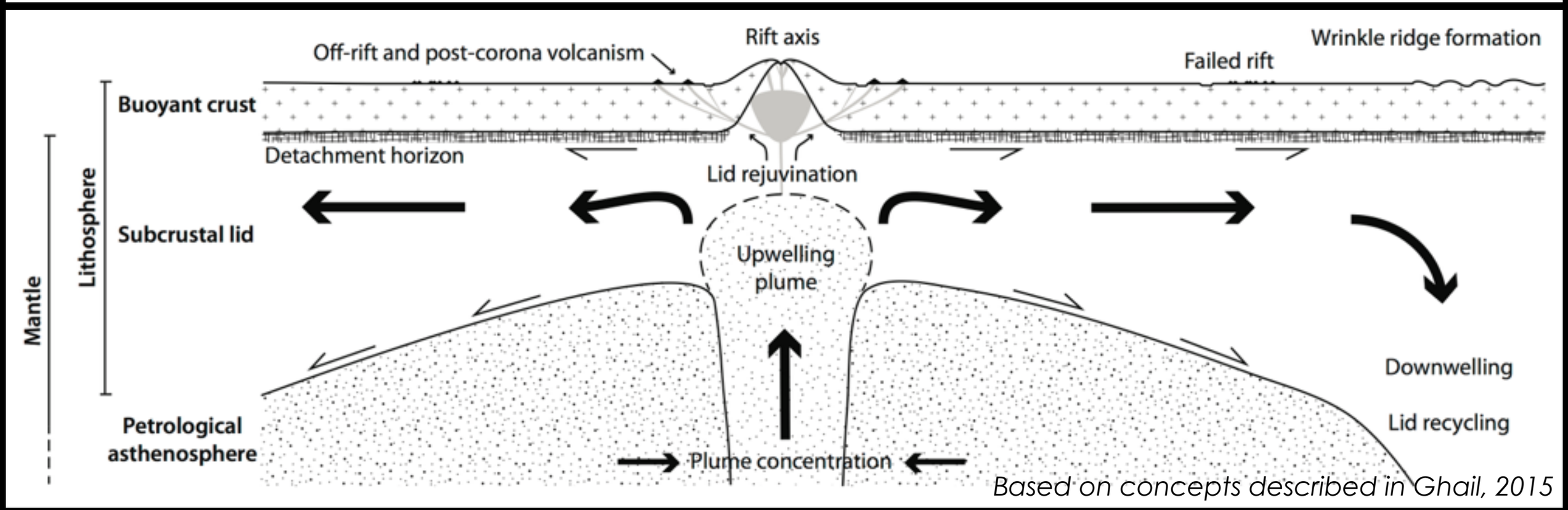
- Strong clustering (slightly less so than Group I)
- Coronae (1) appear random locally, clustered regionally
- Much stronger association with ‘all rifts’, and therefore with older terrain/minor rifting

Group III:

- Int. volcanoes appear random but display off-rift peak
- Shield field clustering associated with old rifts (shield plains)
- Large volcano association more prominent with young rifts
- Of ‘Very Large’ (>500 km) subset, ~75% occur within 350 km of young rifts

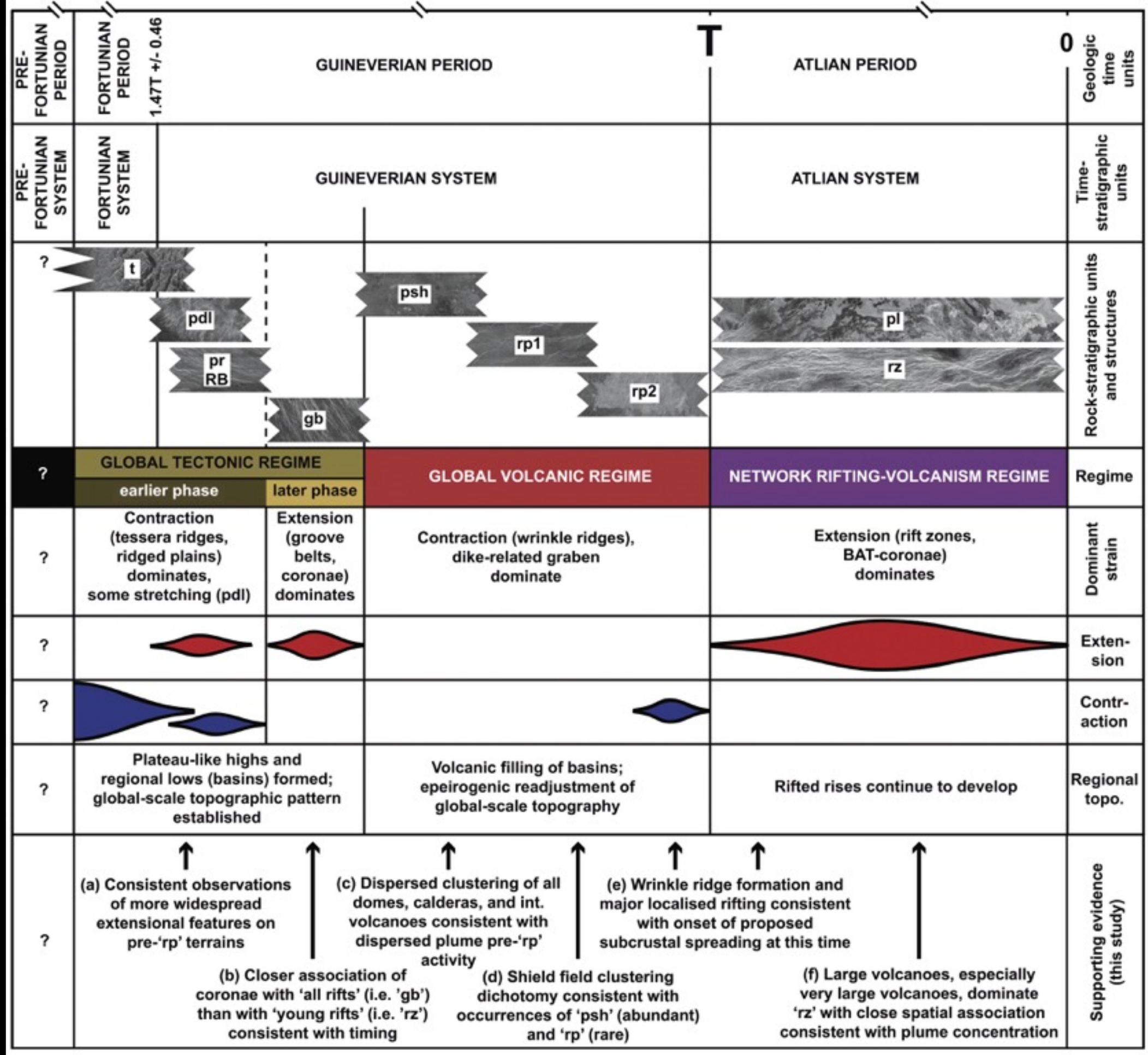
Timing and tectonic Model





Based on concepts described in Ghail, 2015

SYNTHESIS OF EVIDENCE



Modified from Ivanov and Head, 2015

Conclusions

- New method **broadly consistent** with previous studies (e.g. Krassilnikov et al. 2012, Ivanov and Head 2015 etc. and related)
- NNI study shows tendency for **non-random distributions** except shield fields and large volcanoes (appear random)
- **Rift associations (all rifts) unclear** except coronoid
- Young rifts - association weaker in **coronoids: older**
- Young rifts - association stronger in **large volcanoes: younger**
- Focussing of volcanism indicative of global **shift towards subsurface spreading** model (localised)
- Possibly a phase in **longer-term cycle**

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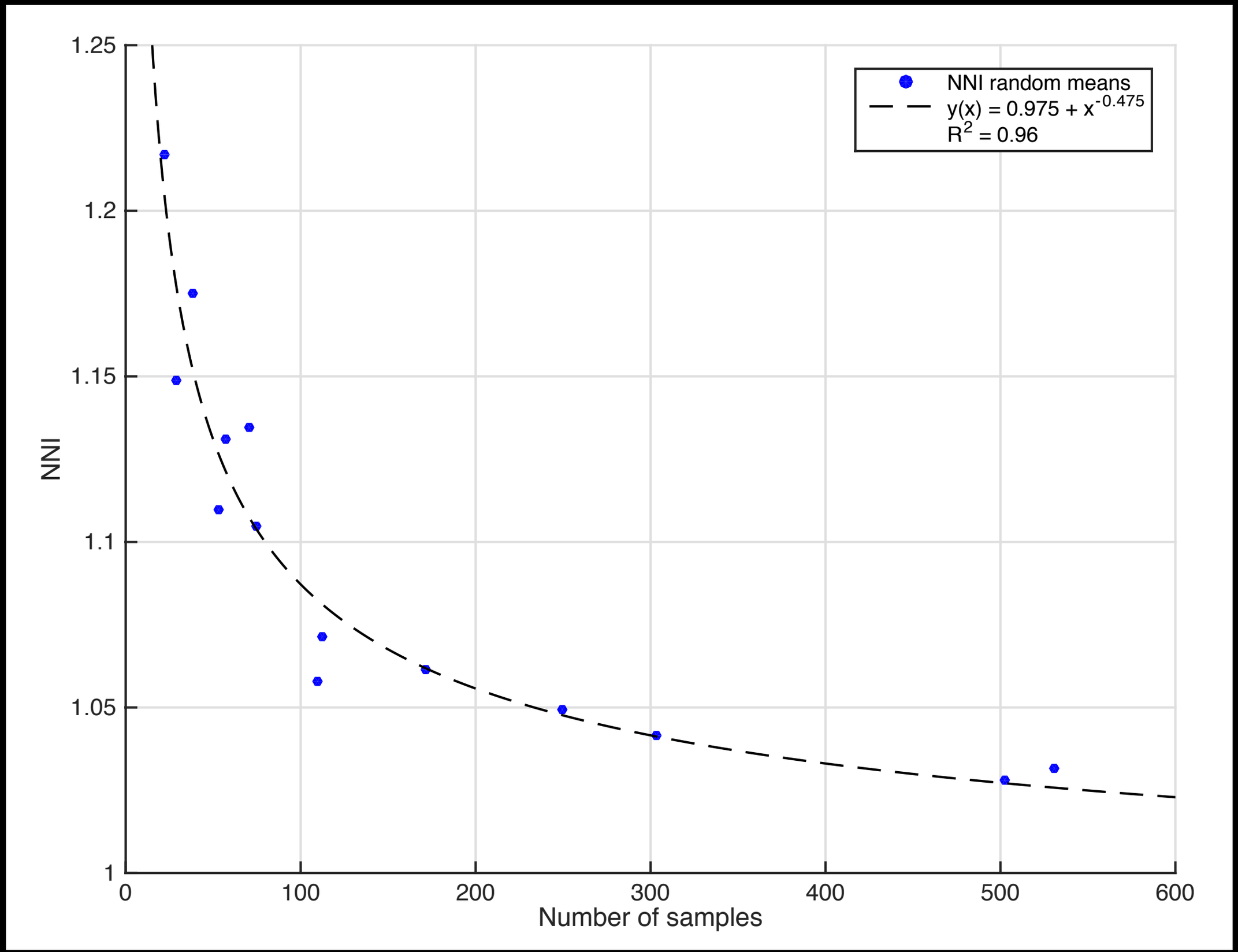
End of Presentation

NNI vs Sample Size



Distance to Nearest Rift