Pre-existing fault-controlled eruptions from the lateral tips of a laccolith in SE Iceland

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Outline

- Space for shallow-level magma movement is commonly generated by deforming the overlying host rock and potentially, the free surface.

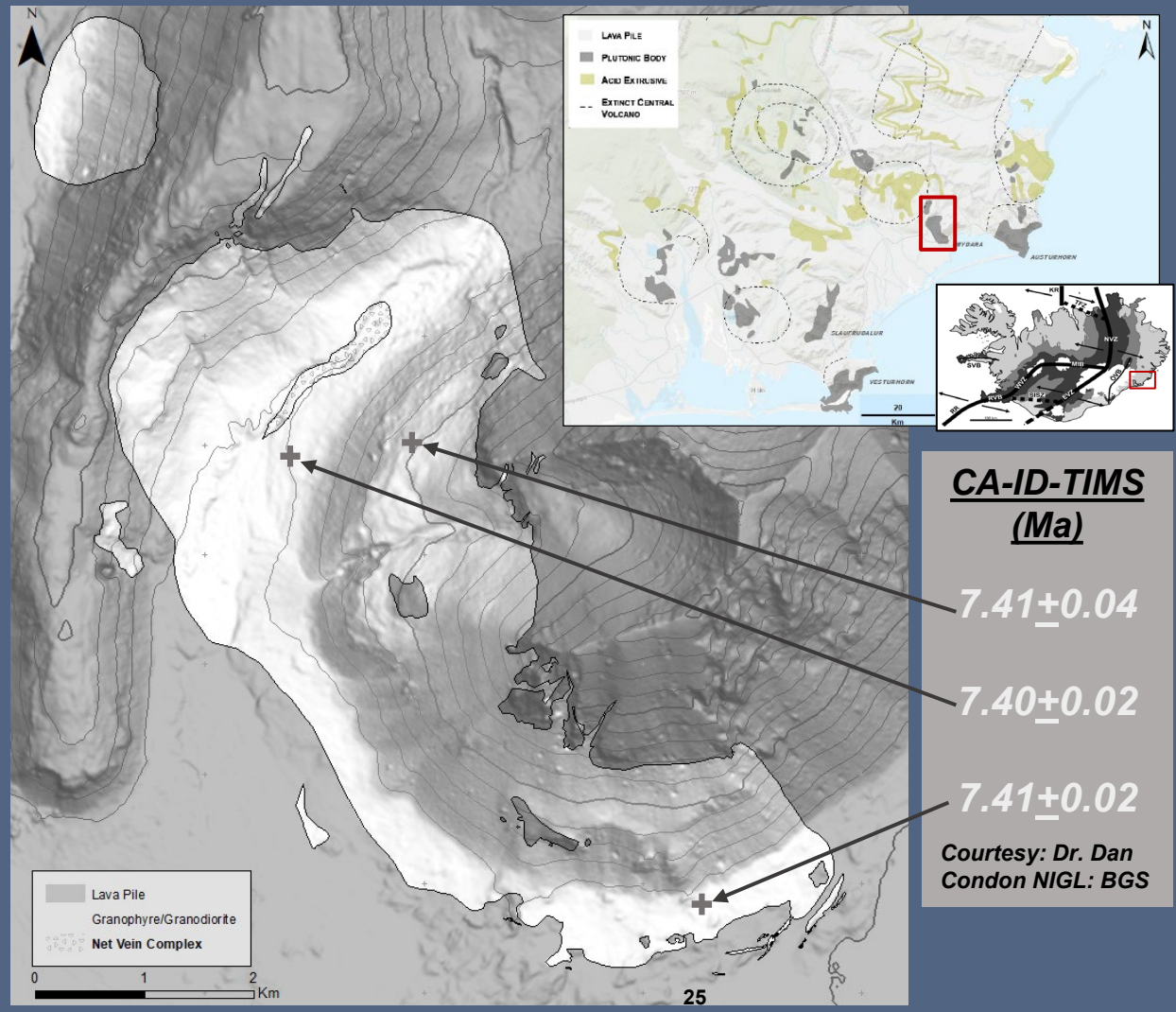
- Interpreting the mechanisms of magma emplacement from the structure and dynamics of intrusion-induced host rock deformation can provide critical insights into the location and spacing of volcanic activity.

- Many inferred intrusion geometries from deformation patterns which may not fully correspond with the true morphology and flow dynamics the underlying intrusions

Aims

- Assess the interplay between host rock deformation and magma flow dynamics during the formation and evacuation within and around the shallow-level, ~7.4 Ma, silicic Reyðarártindur Laccolith in SE Iceland

- Link the inferred rate and dynamics of magma flow within the silicic intrusion using Anisotropy of Magnetic Susceptibility (AMS) analysis and ID-TIMS U-Pb age dating with quantitative deformation patterns in the surrounding structural aureole from detailed mapping and UAV-based photogrammetry



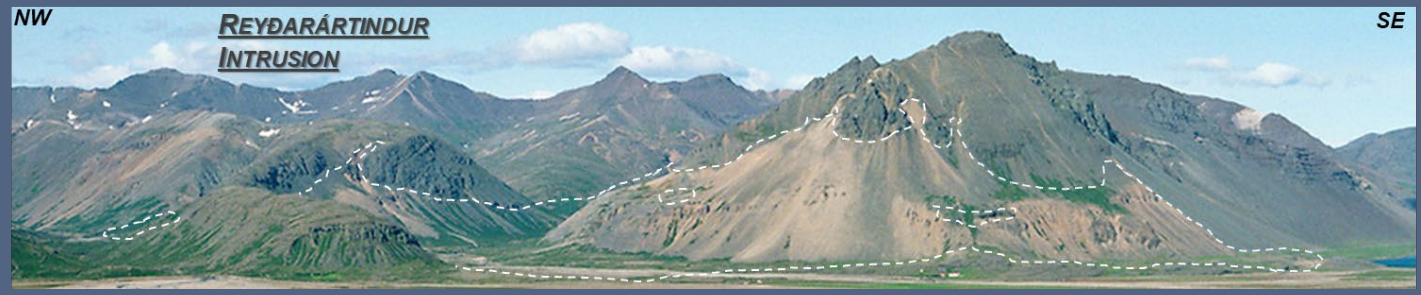
CA-ID-TIMS (Ma)

7.41±0.04

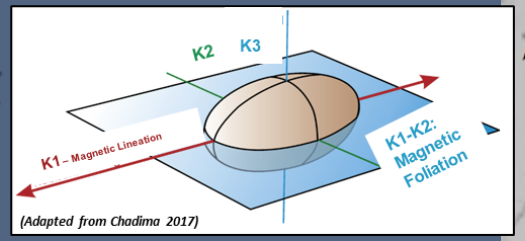
7.40±0.02

7.41±0.02

Courtesy: Dr. Dan Condon NIGL: BGS



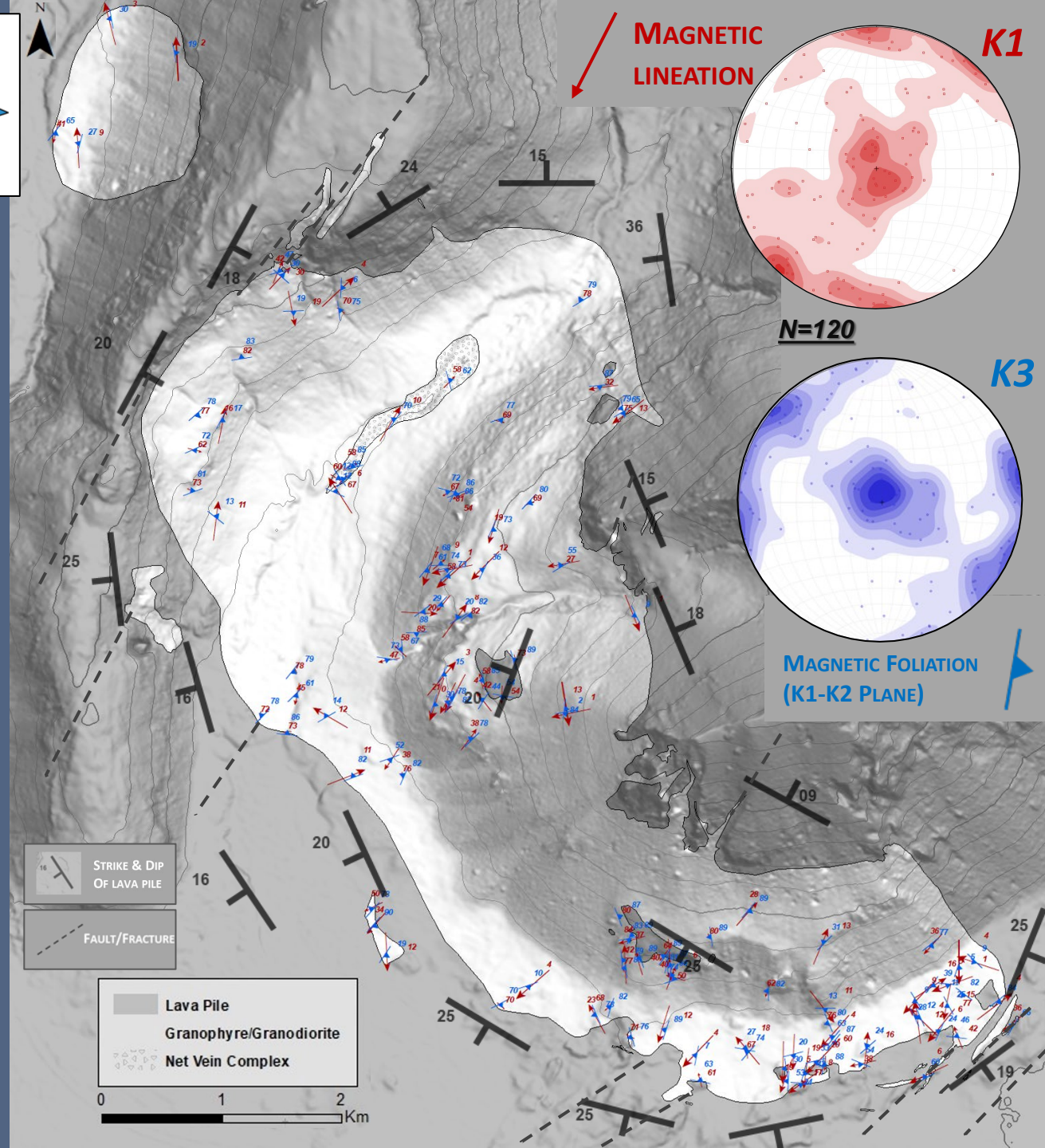
Anisotropy of Magnetic Susceptibility (AMS)



- AMS fabric data is generally dominated by two distinct populations; a gently and steeply inclined SW-NE trend and strike dominating the primary magnetic lineation (K1) and, foliation pattern (K1-K2 Plane) respectively within the magnetic tensor

Host Rock Deformation

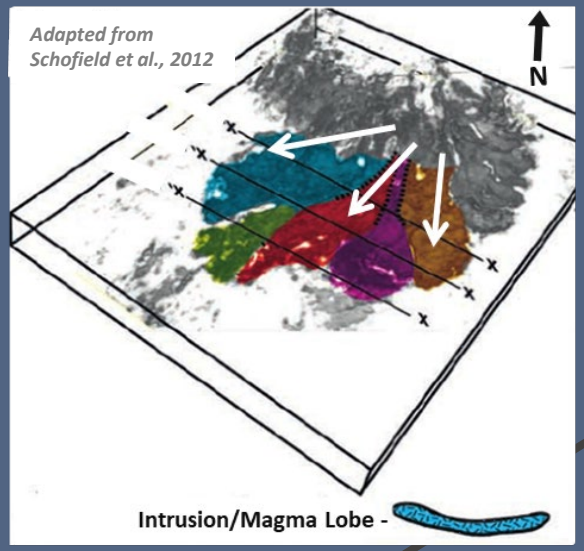
- Host basaltic lavas defined by a gently domed intrusion-induced forced fold geometry
- Intrusion of granite deflected gently inclined lava piles to define a blister like structural aureole
- NE-SW steeply dipping fault arrays across the structural aureole



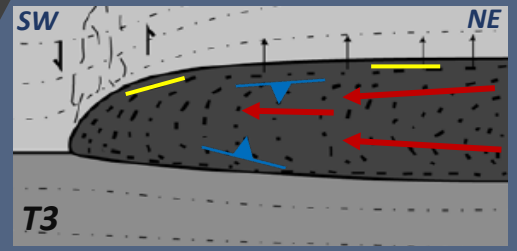
Interpretation of AMS Fabric

- **Internal architecture of main body of the intrusion defined by laterally emplaced, coalesced magma lobes consistently orientated along SW-NE primary flow axes.**

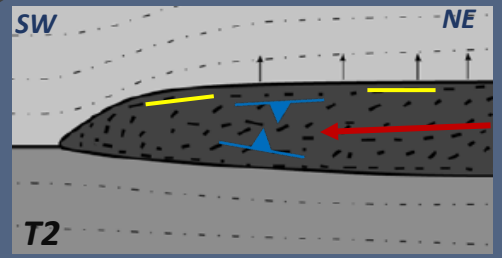
- **Coalescence of the magma lobes produced a domed-shaped, forced fold in the host rock**



Time (T)

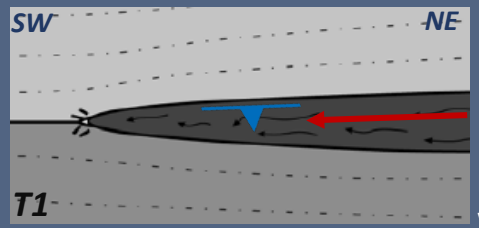


Elastic & inelastic deformation of host rock during emplacement

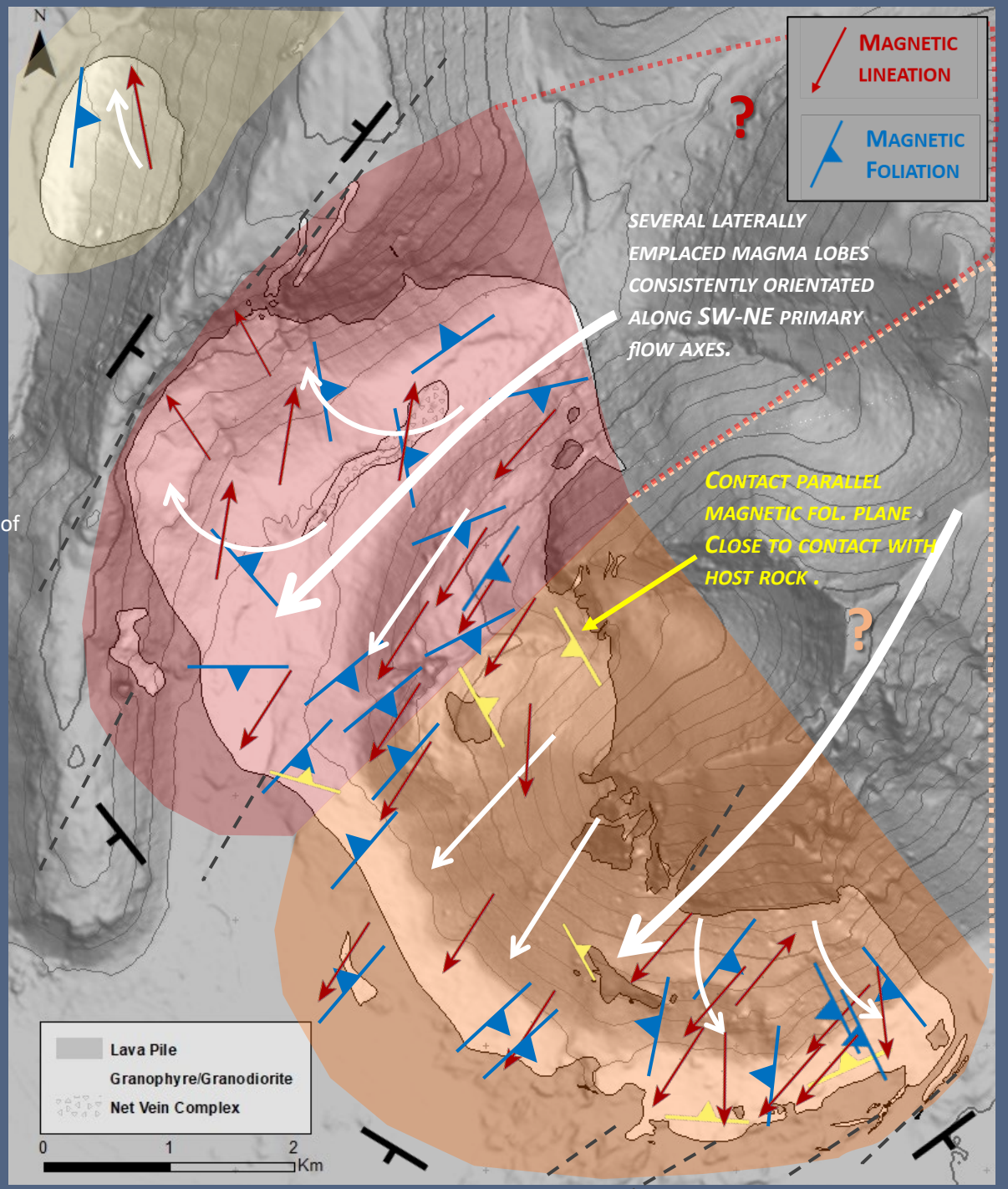


Vertical inflation & pure shear flatteneing of sheet

Adapted from
McCarthy et al., 2015



Lateral emplacement of sheets with primary NE-SW flow axis



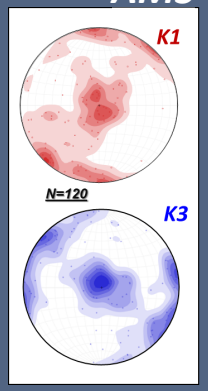
HOST ROCK STRUCTURES

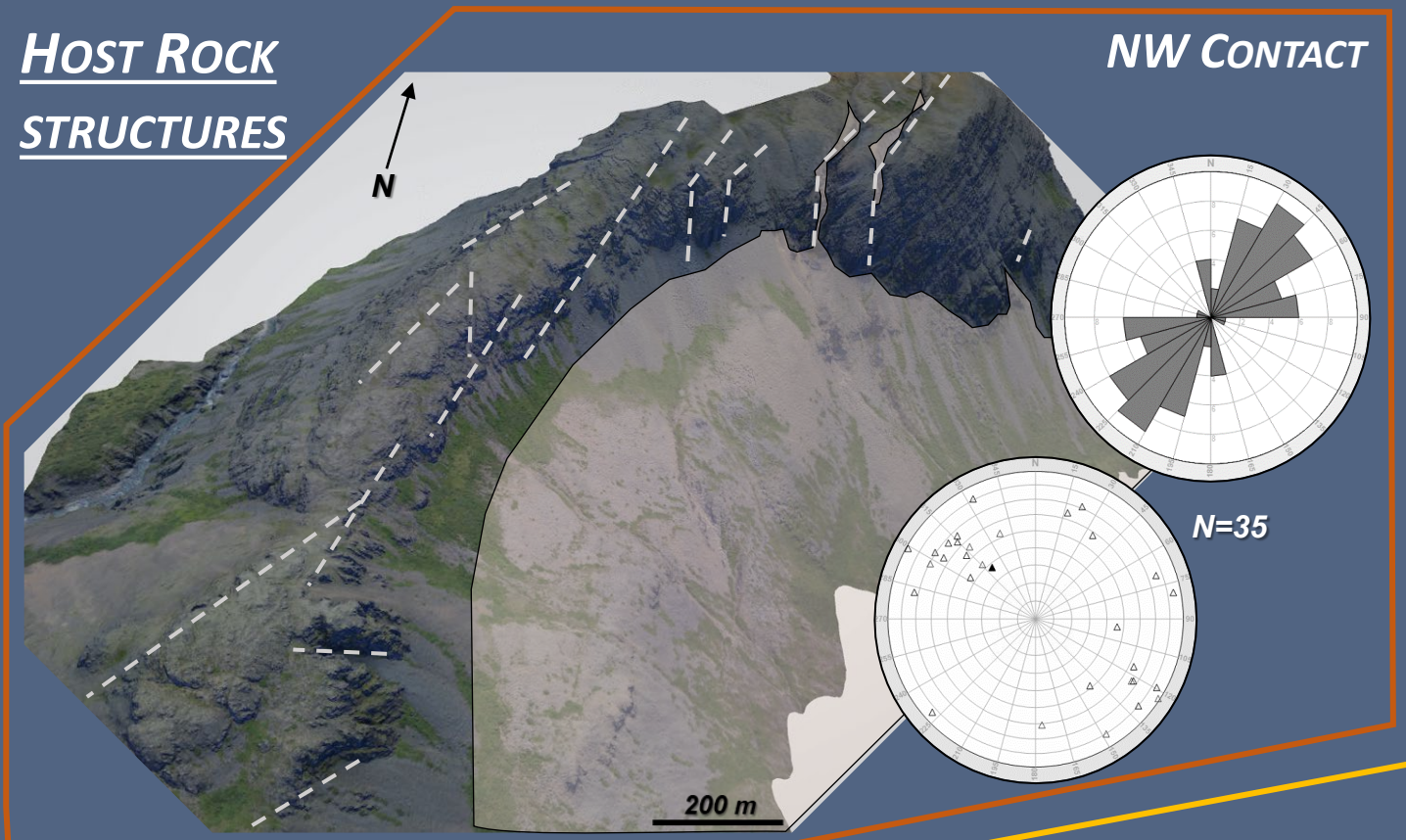
UAV orthophotographs of NE & SSE Contacts

Circular histograms of fracture/fault sets measured from the host rock (Datamine; SIROVISON 6.2) are mainly parallel to the SW-NE primary magnetic lineation (K1) and, foliation pattern (K1-K2 Plane) AMS fabrics in the intrusion.

…which in turn parallels the trend of the regional dyke/fissure swarms (e.g. Torfason 1979 Burchardt et al., 2012)

Poles to Strike/dip of fracture/fault sets contemporaneous with gently inclined K3 magnetic tensor (Poles to steeply inclined magnetic foliation)

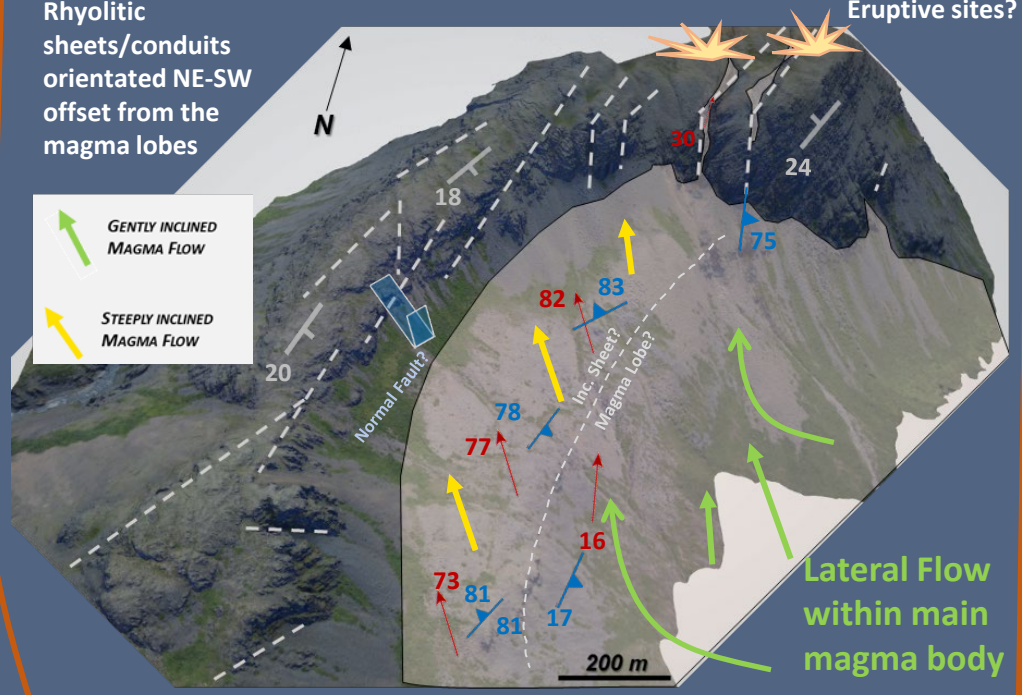


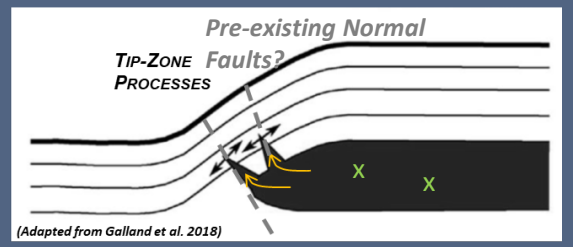


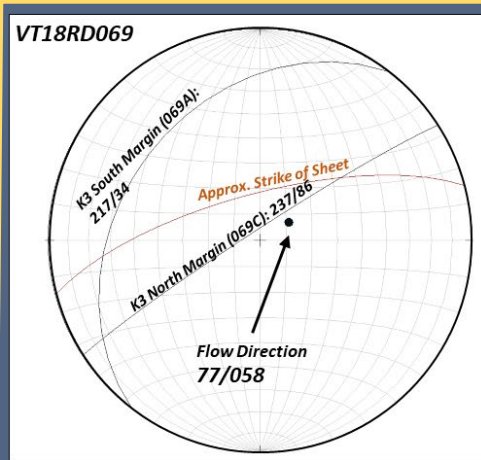
Further Linking Host Rock Deformation Structures To Magma Flow Fabrics

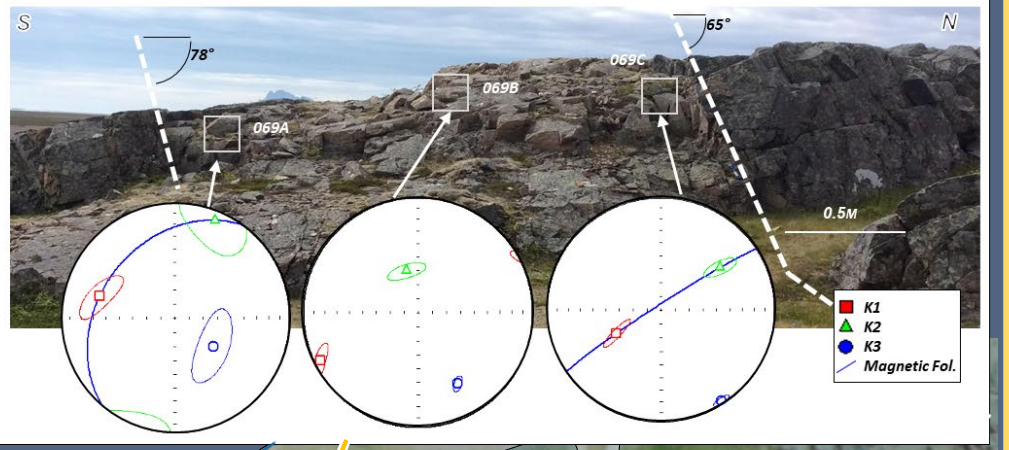
Rhyolitic sheets/conduits orientated NE-SW offset from the magma lobes

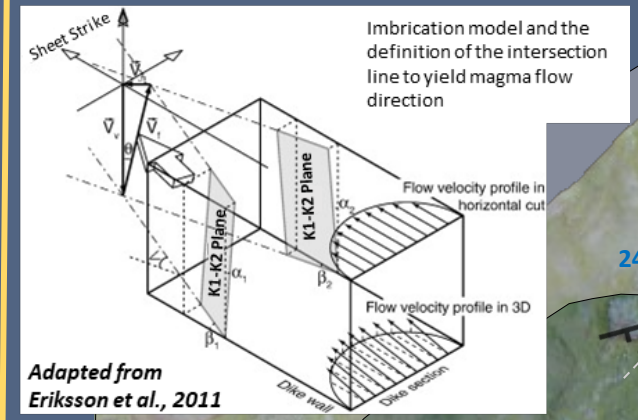
Eruptive sites?





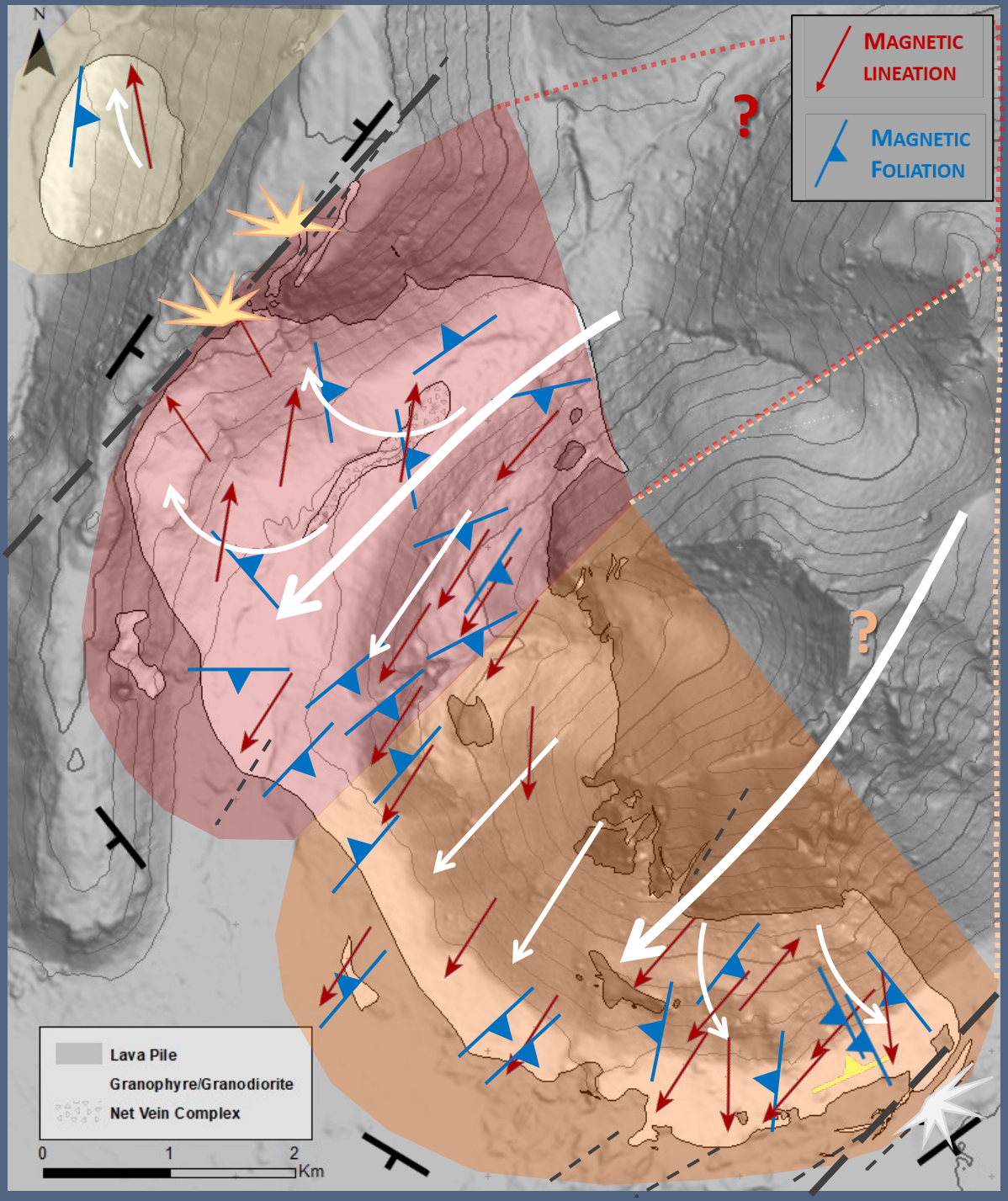


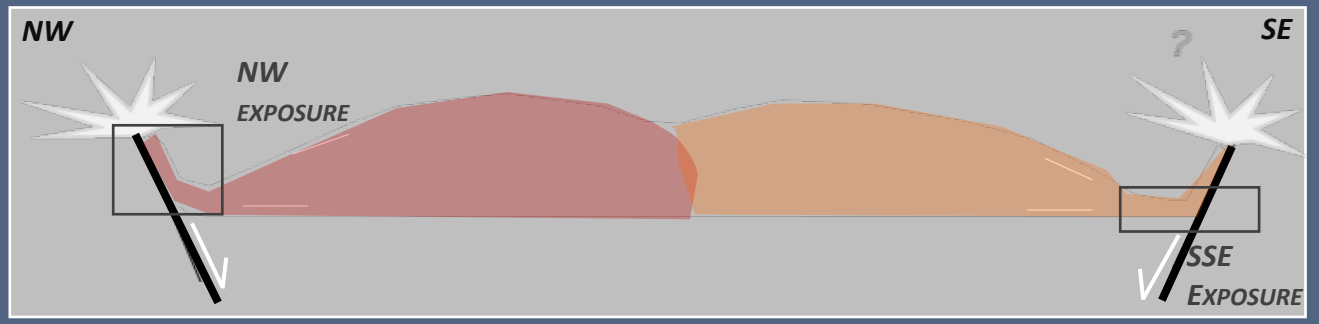




Sub-vertical flow direction from imbrication model within inclined magma sheets offset from main laccolithic body

SUMMARY & CONCLUSIONS - REYÐARÁRTINDUR LACCOLITH IN SE ICELAND





- AMS data demonstrate the main body of the Reyðarártindur Laccolith consists of incrementally emplaced coalesced magma lobes along NE-SW primary flow axis
- NW & SE boundaries bounded by pre-existing ENE-WSW regional, extensional faults within basaltic host rock
- Rhyolitic/granophyric sheets offset from the magma lobes are inferred through AMS to migrate upward along these pre-existing faults, thus acting as preferential pathways for magma laterally thus offsetting eruption sites by tens to hundreds of metres from the underlying main intrusion.
- Field evidence supporting interpretations where pre-existing faults act as preferential pathways for magma laterally offsetting eruption sites by tens to hundreds of metres from the underlying main intrusion.