

*40<sup>th</sup> Anniversary*

# Petrology of the Hornfels Zone around the Hrossatungur Gabbro, W-Iceland

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# Outline of presentation

- Geological settings (Hrossatungur gabbro and surroundings)
- Research objectives
- Methodology
- Results
- Hornfels in well HE-42 in Hellisheiði high-T field
- Conclusions



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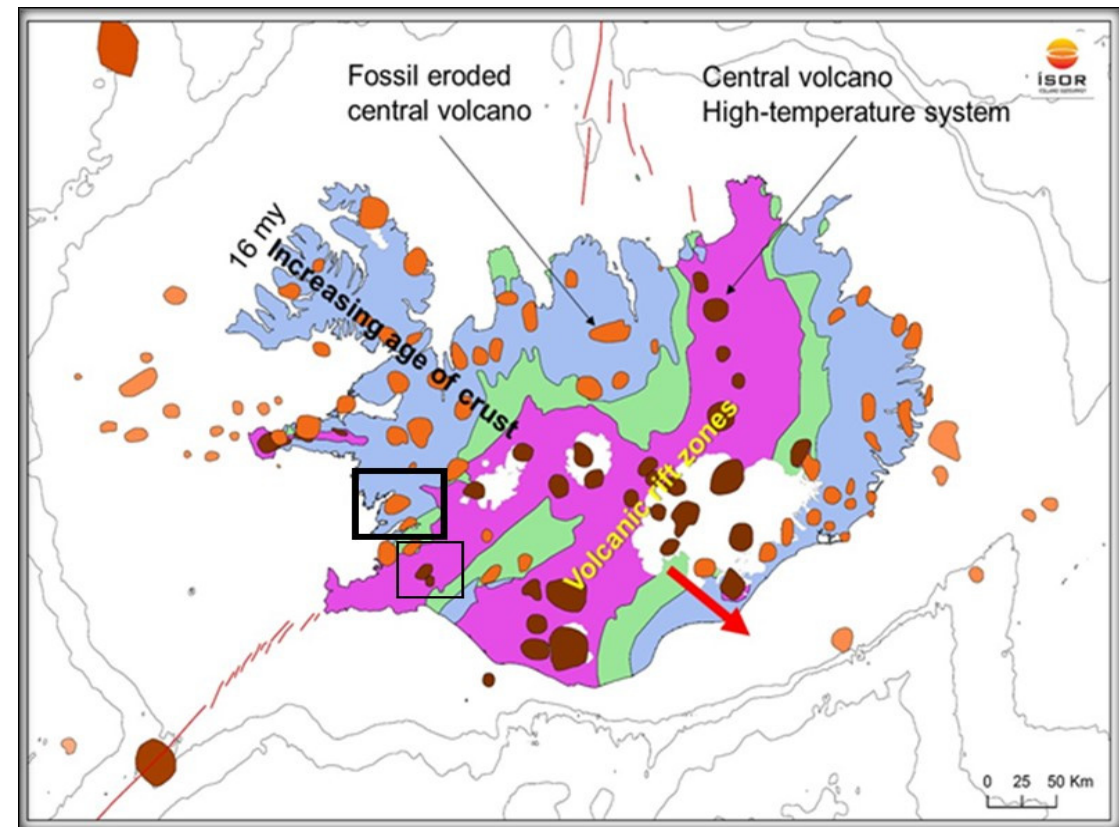
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# Geological settings

- Iceland located on the Mid-Atlantic Ridge and underlain by anomalous mantle plume
- The map shows the location of the active and fossil central volcanoes
- Hafnarfjall-Skarðsheiði (fossil) Tertiary central volcano and located about 100 km north of Reykjavik
- The Hellisheiði High-T field



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# Objectives

- To study the hornfels contact rocks around the heat source (gabbro) in order to **find evidence either for the infiltration of the groundwater towards the magma or the outwards conduction of the heat from the magma into the surrounding rocks and geothermal system**
- A **comparative** study with a **hornfels** zone in well **HE-42** at Hellisheiði high temperature system and with **other hornfels locations** that have been studied in a similar way



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# Methodology

- **Binocular microscopy** to identify the rock characteristics such as texture, rock type, primary minerals and hydrothermal alteration intensity (**52 samples**)
- **Petrographic analysis** of about (**33 samples**)
- **Scanning electron microscope SEM (9 samples)** and partly **electron microprobe EMP (5 samples)** analysis to identify the mineralogy of the hornfels
- **ICP-OES** analysis to evaluate the chemical change during the hornfels processes (**30 samples**)
- **Loss on Ignition** measurements to estimate the water and carbon content within the hornfels zone (**30 samples**)



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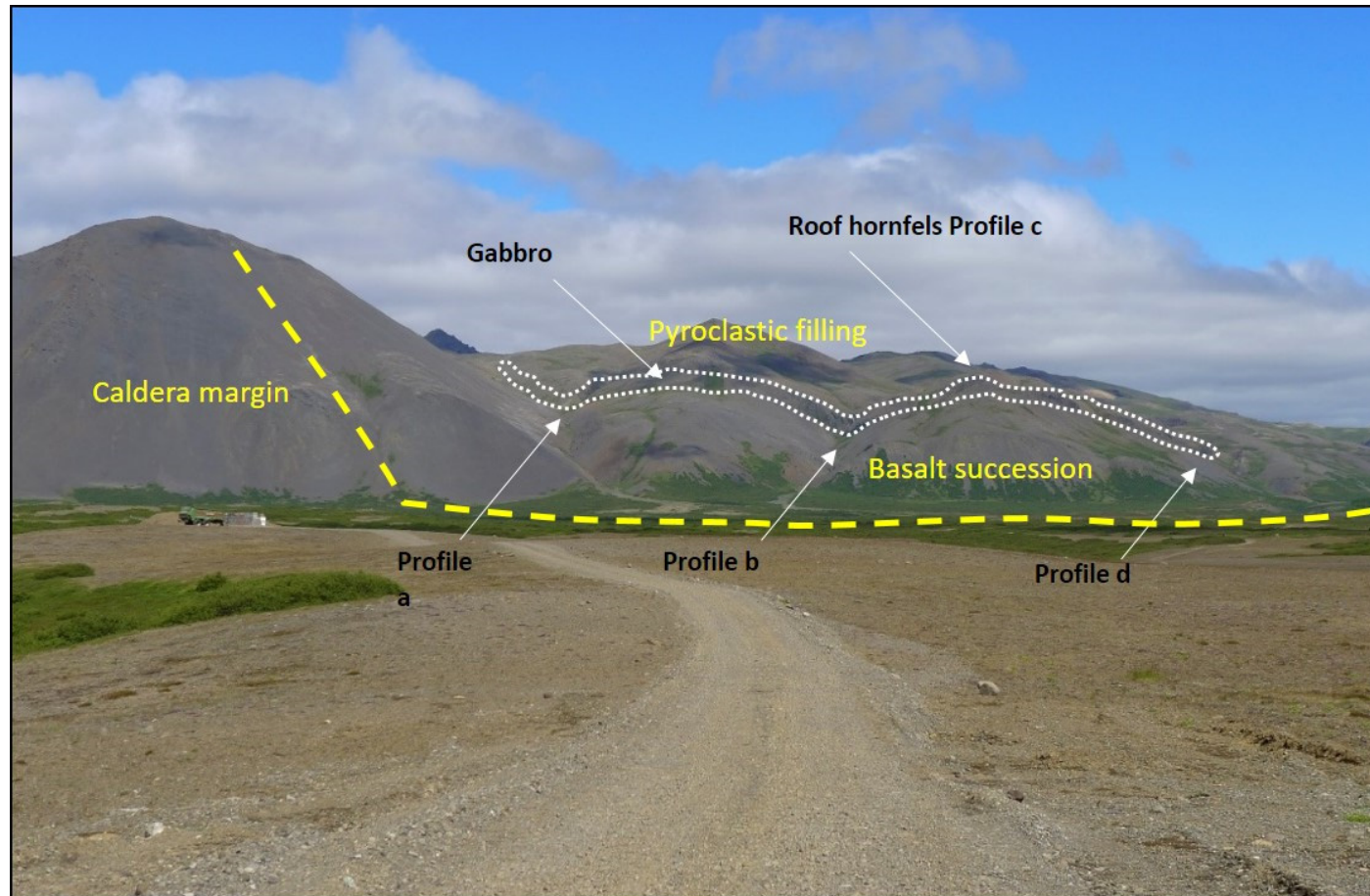
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# A view of the Hrossatungur gabbro



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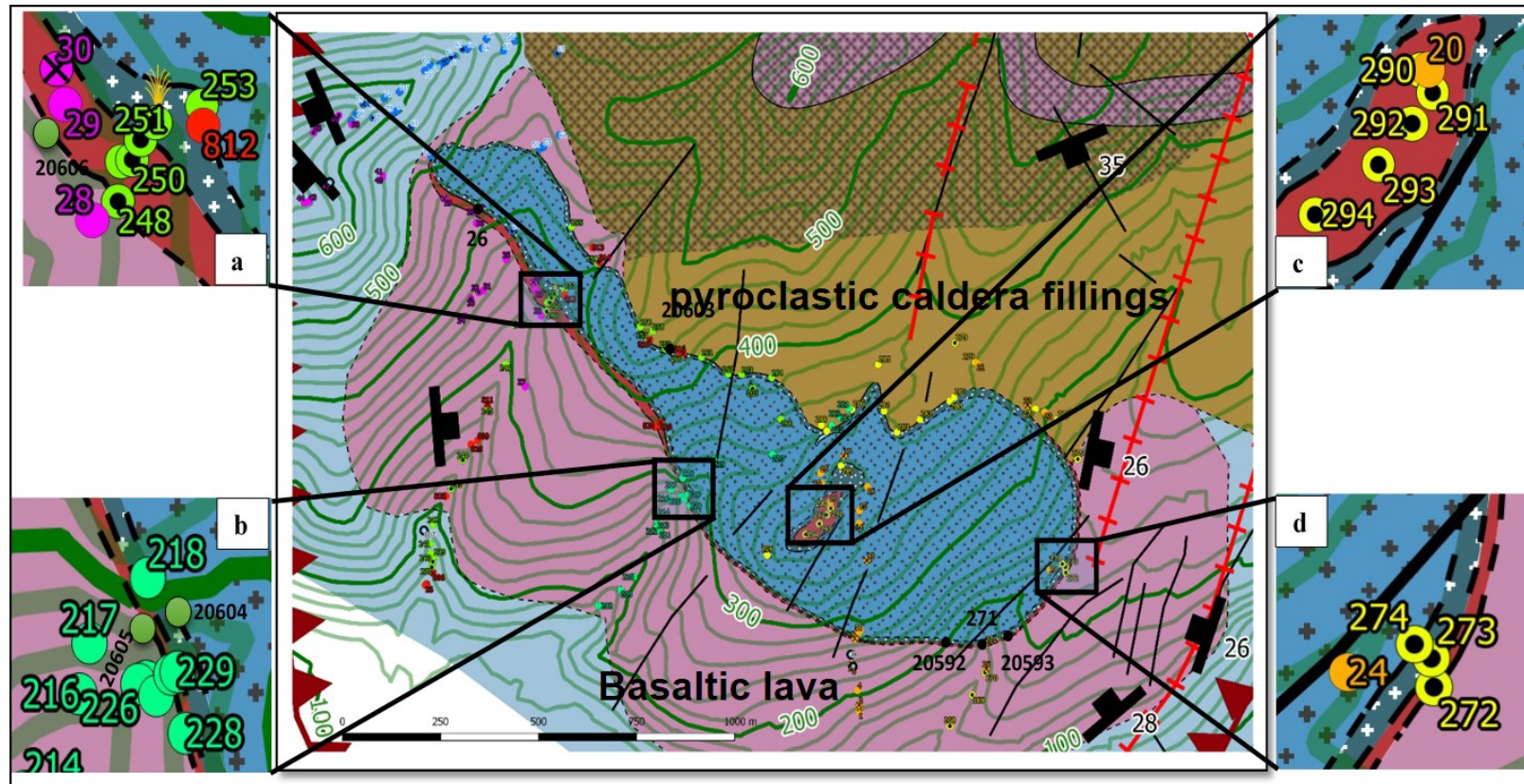
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# Sampling map of Hrossatungur gabbro and hornfels zone



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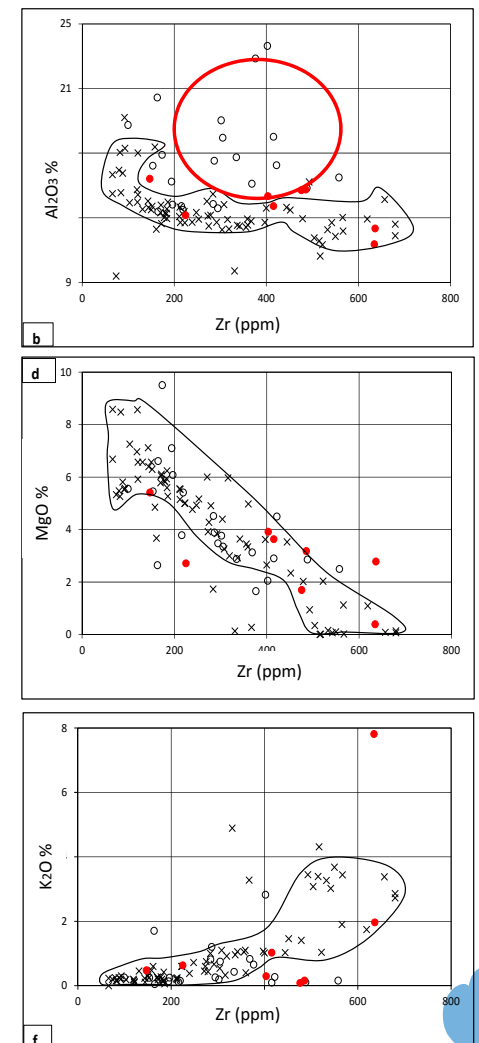
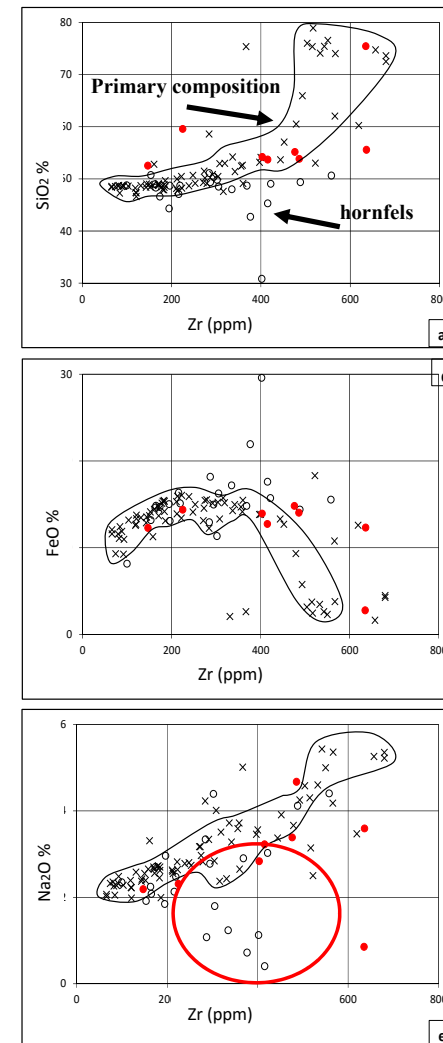
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# ICP-OES analysis

Is there a chemical change due to hornfels alteration?

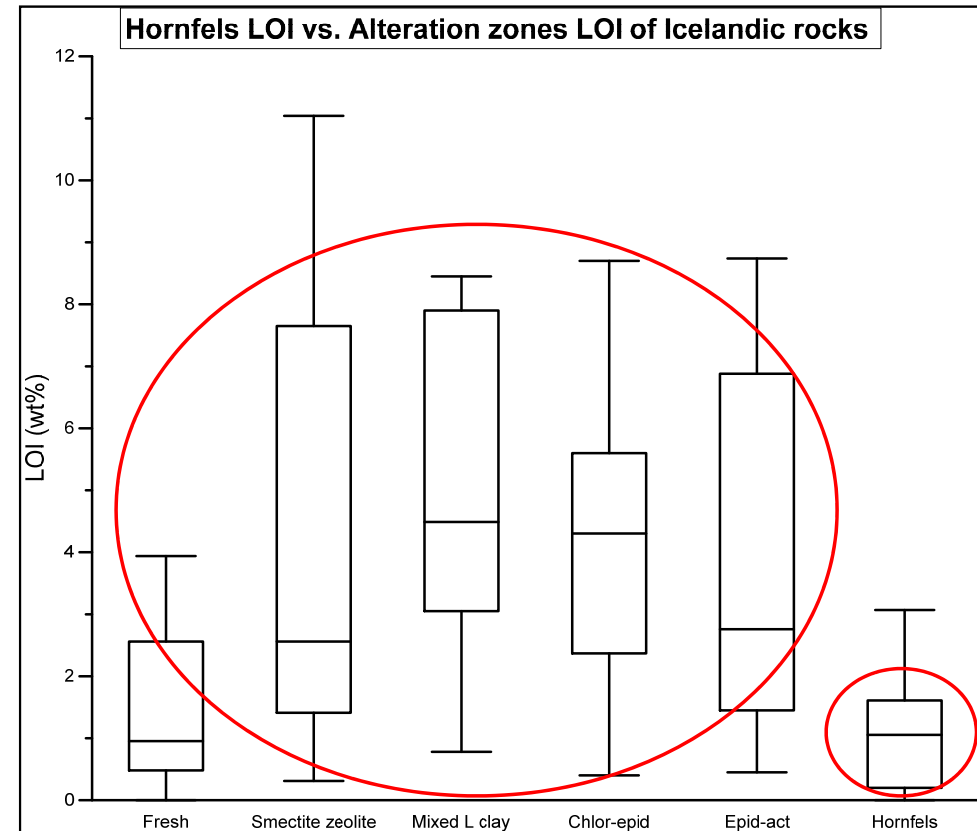
- The hornfels composition compared results to the least altered rocks (primary) which collected from the Hafnarfjall central volcano
- Samples falling outside the primary compositional field would imply mobility of these oxide or trace element
- Overall compositional range is in many ways similar to the fresh rock equivalent of the volcano
- However, there seems to be an apparent overall enrichment of  $\text{Al}_2\text{O}_3$  and depletion of  $\text{Na}_2\text{O}$





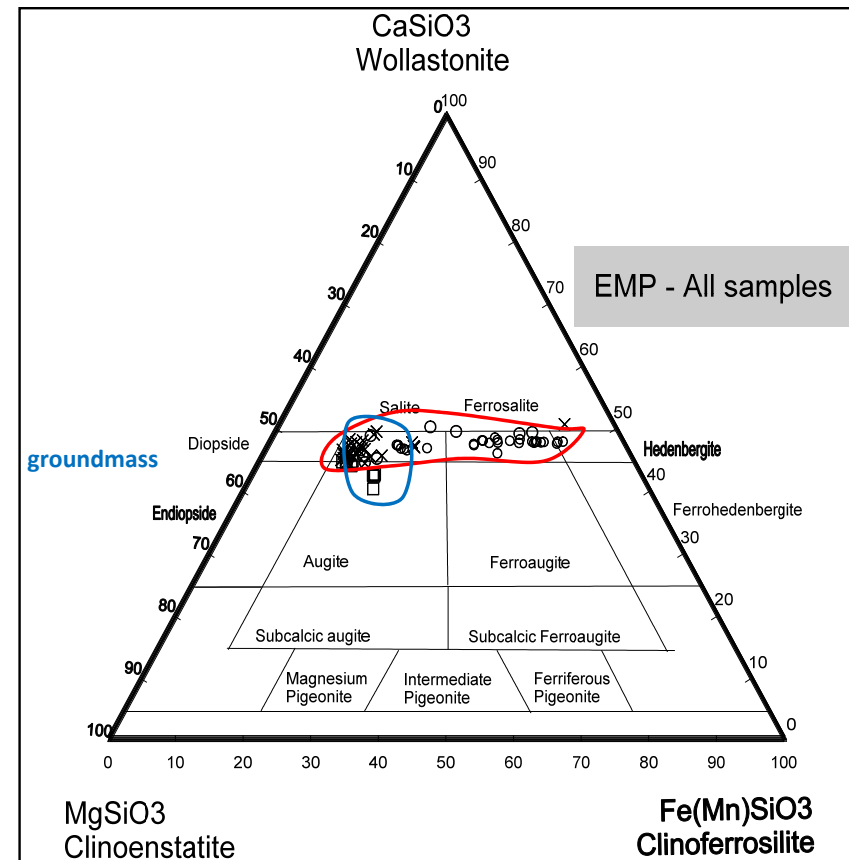
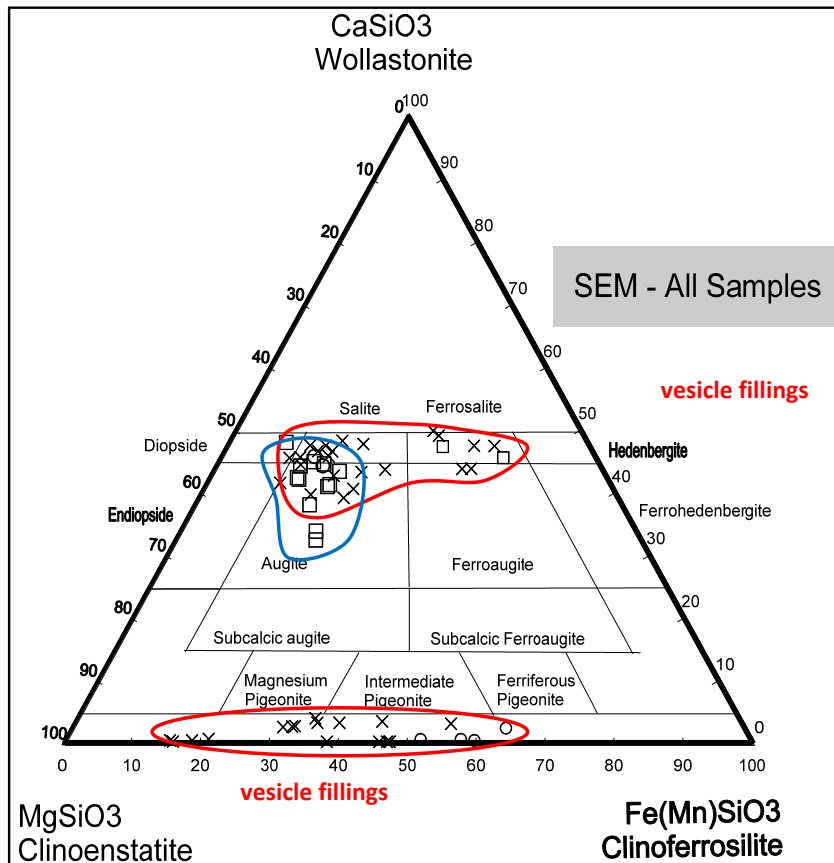
# Loss on Ignition (LOI)

- Normal high temperature alteration zones have high LOI (H<sub>2</sub>O, CO<sub>2</sub>)
- LOI reaches a minimum at the hornfels stage
- The hornfels is driving the water away
- Hornfels mineralogy is dominantly composed of water-free minerals like pyroxene, plagioclase and oxides; also minor garnet and amphibole

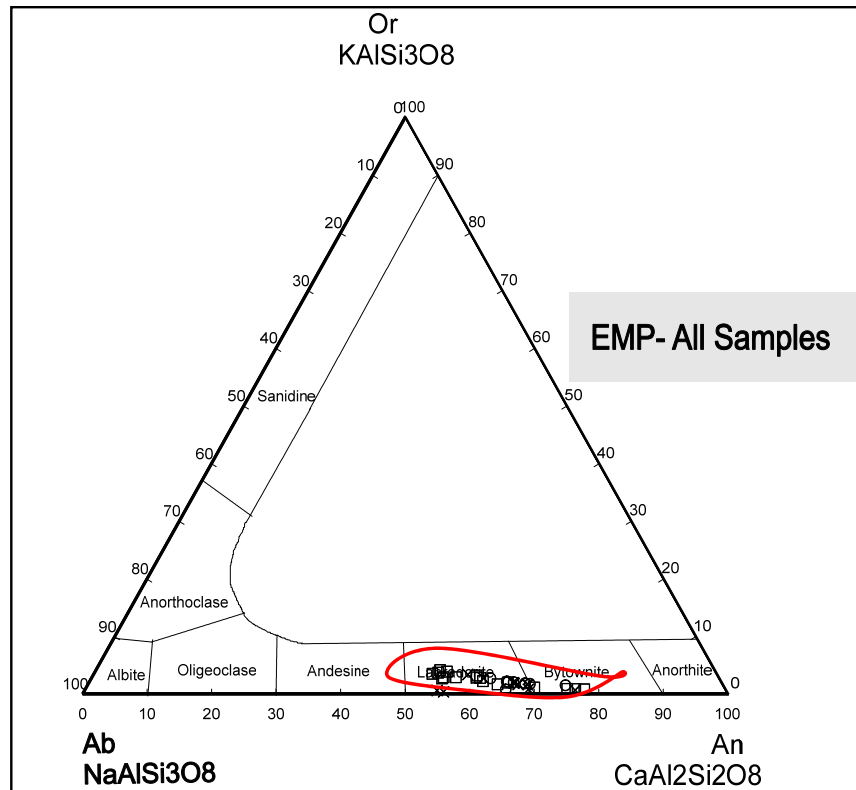
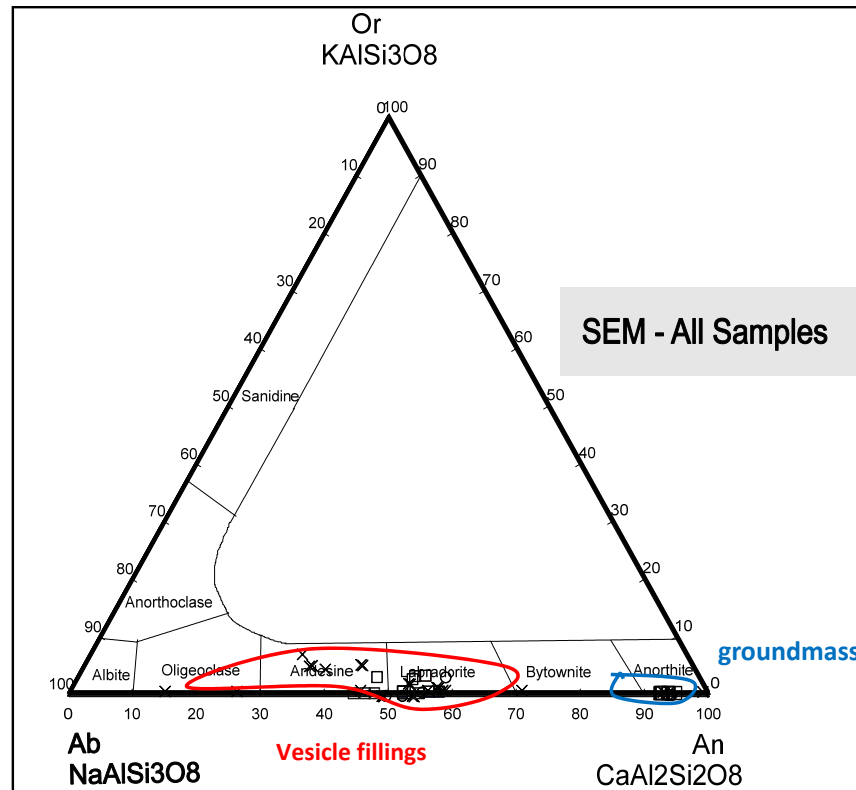


# Scanning electron microscope and electron microprobe

## Composition of pyroxene in the HTG hornfels (vesicle fillings and groundmass)

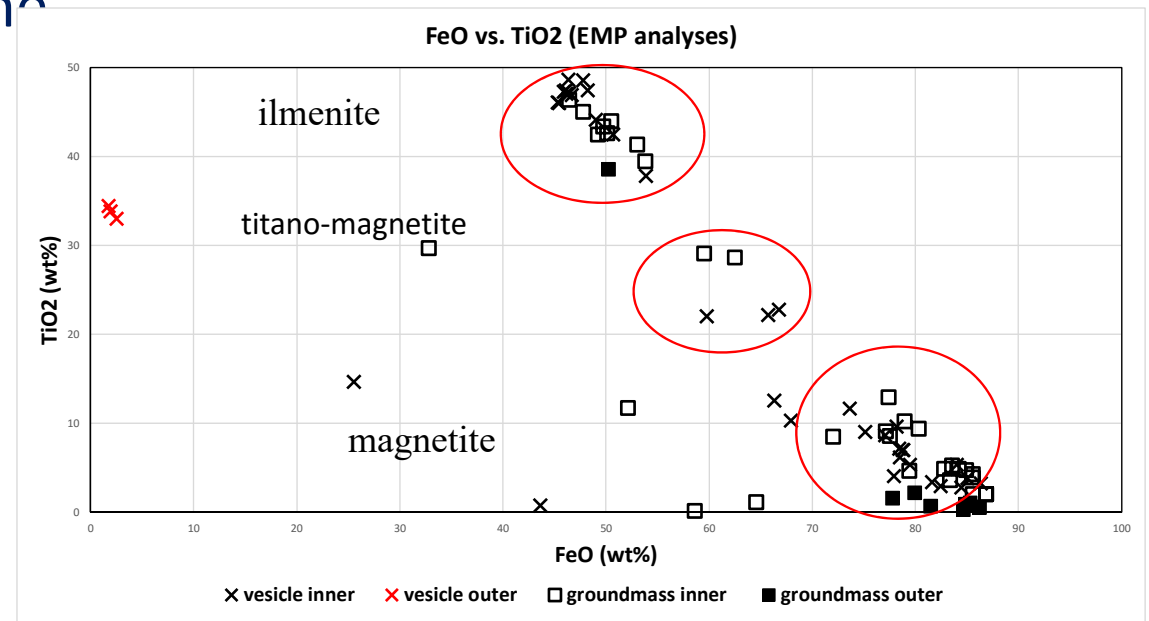


# Composition of plagioclase in the HTG hornfels



# Composition of oxides in the HTG hornfels

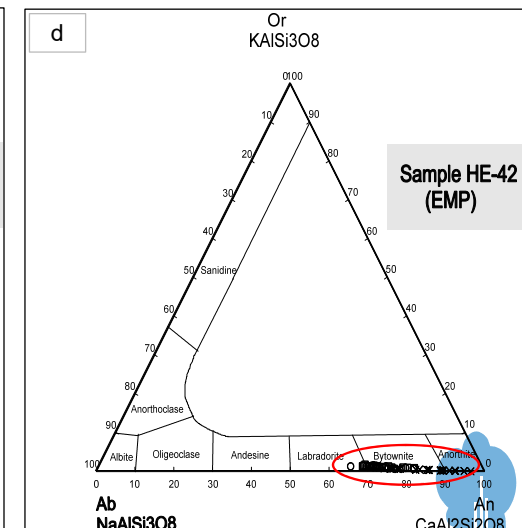
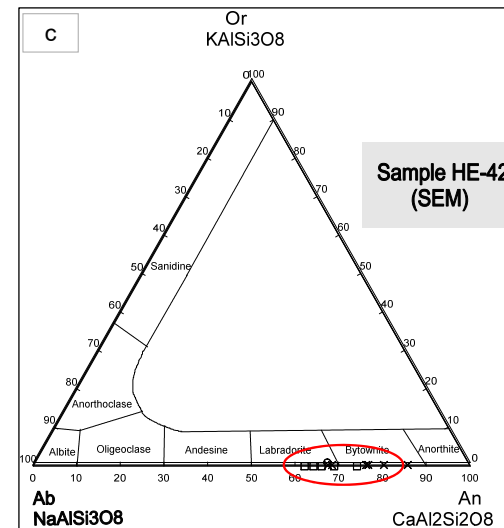
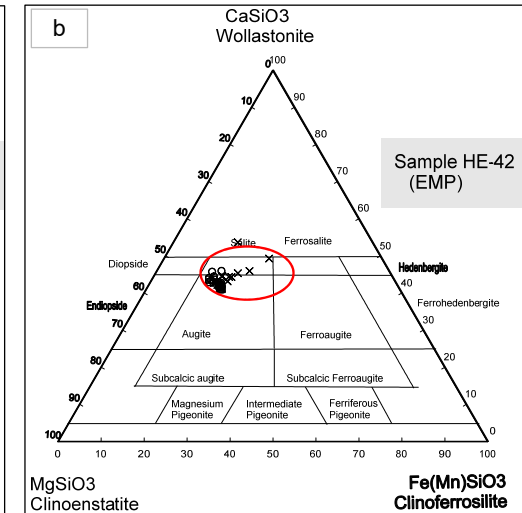
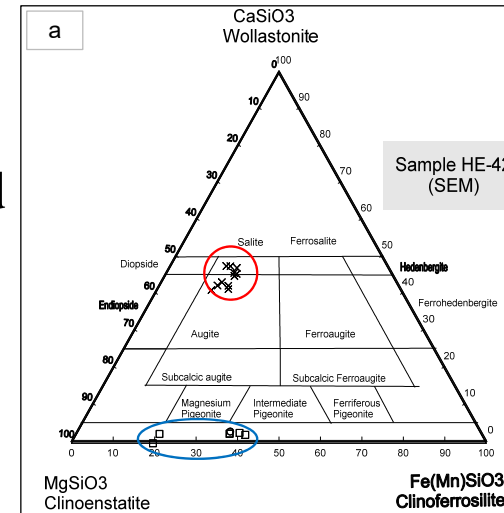
- Oxides are major minerals in the hornfels contact zone
- Dominantly magnetite (vesicle fillings) and ilmenite compositions (groundmass)
- A number of analysis fall in between as titanomagnetite



# Mineral composition in the HE-42 hornfels (1500 m depth)

Hrossatungur hornfels & hornfels  
found in the active high-temperature field

- Pronounced **granoblastic** crystallization of the hornfels
- Pyroxene composition is **less Fe-rich** (salite-augite)
- Orthopyroxene is **Mg-rich** in groundmass
- Plagioclase composition is **more Ca-rich**



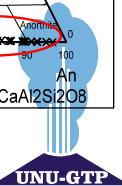
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# Conclusion

- The transfer of heat from the intrusion was **convective** on the **north** side but **conductive** on the **south** side which is indicated by difference in hornfels thicknesses
- Loss-on-ignition indicates that the heating from the gabbro drives the water away (**hydrous** alteration minerals ➡ **water-free minerals**)
- The ICP-OES indicates that hornfels **compositions** is similar to the fresh rock equivalent of the volcano
- Pyroxene composition **salite-augite-ferrosalite- minor diopside-hedenbergite**
- Plagioclase shows a wide range of compositions in the HTG hornfels zone (**andesine-anorthite**)
- A comparison between HTG hornfels and HE-42 at Hellisheiði indicates a more pronounced **granoblastic** crystallization where the pyroxenes are less **Fe-rich** (salite-augite) and the plagioclase more **Ca-rich** (labradorite to anorthite) in well HE-42



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# Thank you for your attention



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