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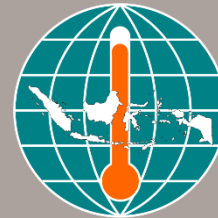
ANALYZING ALTERATION MINERALOGY IN GEOTHERMAL DRILL SAMPLES WITH INFRARED SPECTROSCOPY

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FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION



GEOCAP

Geothermal Capacity Building Program Indonesia - Netherlands

RESEARCH PROBLEM (1)

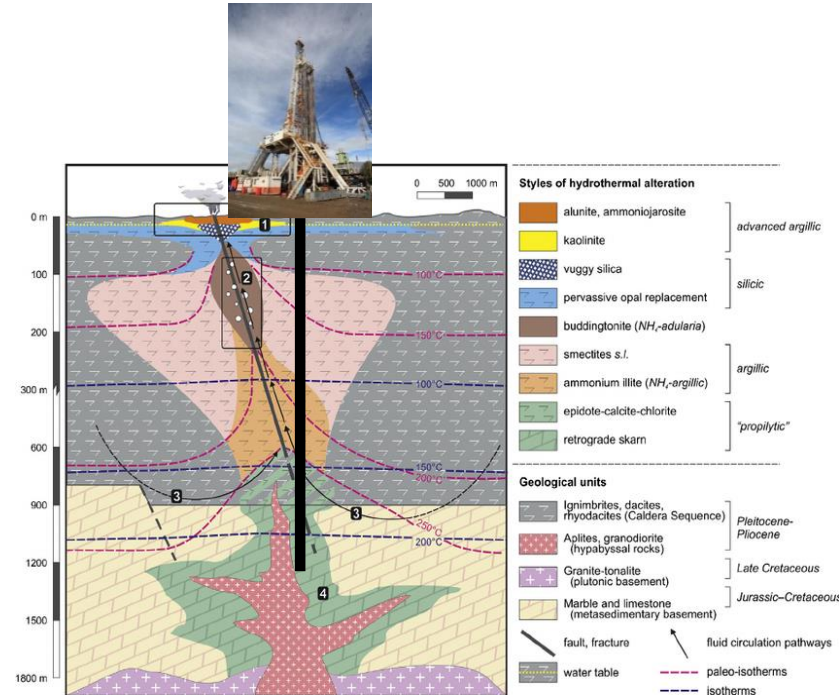
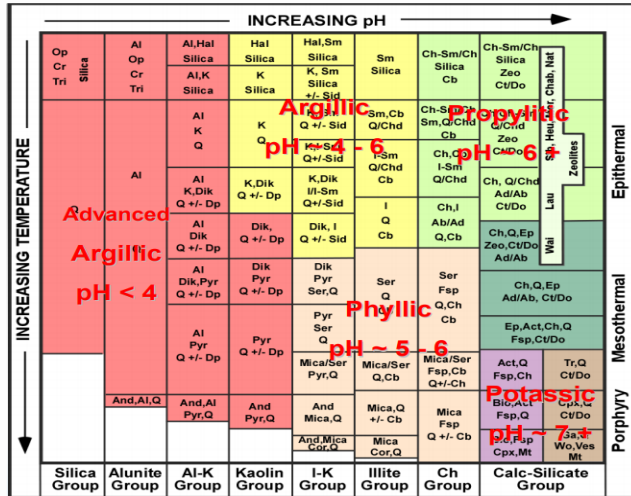
- Hydrothermal alteration in geothermal Systems => alteration mineralogy



Kaolinite clay alteration, Rift Valley, Ethiopia

RESEARCH PROBLEM (2)

- Alteration of rocks in subsurface => expression of subsurface conditions

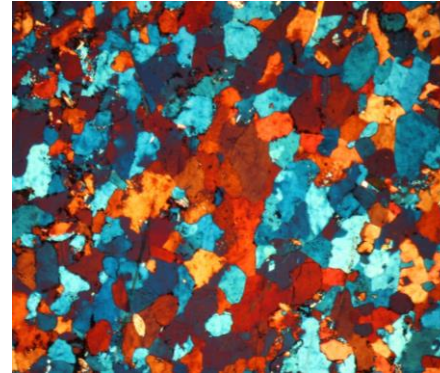


Sources: Canet et al (2015), Leach (1995)



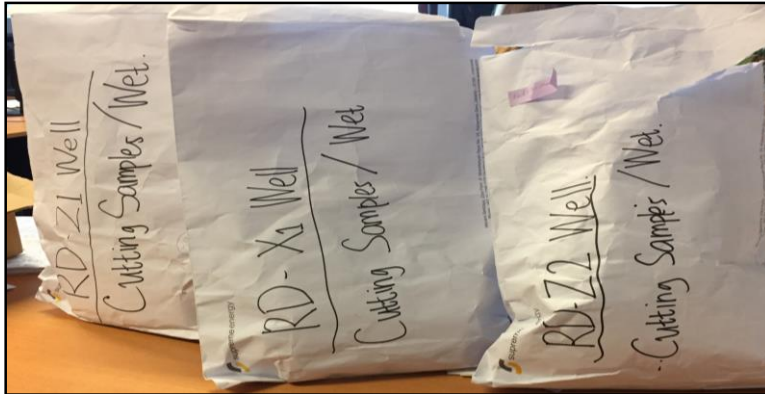
RESEARCH PROBLEM (3)

- Traditionally: Methylene Blue and binoc. microsc. at well site
 - Unresolved: Which clay? Composition of minerals?
- Lab methods: XRD, XRF, thin sections, fluid inclusion etc.
 - only available for next well



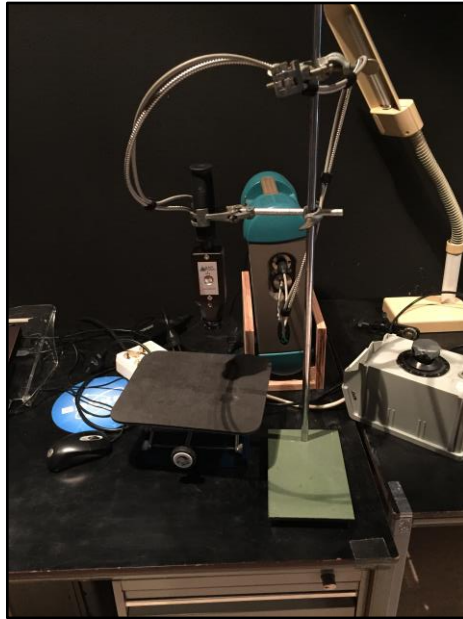
INFRARED SPECTROSCOPY

- Geothermal field in Sumatra, Indonesia
 - 80 cuttings from 3 different wells
- => Investigate what spectroscopy can add on site

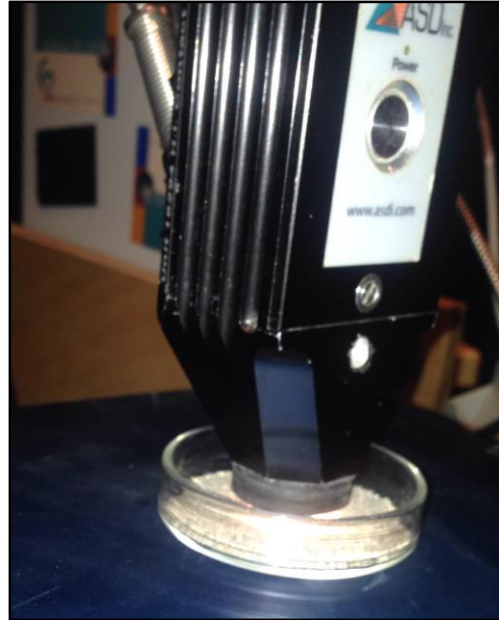


INFRARED SPECTROSCOPY

- ASD visible to Shortwave infrared reflectance spectrometer



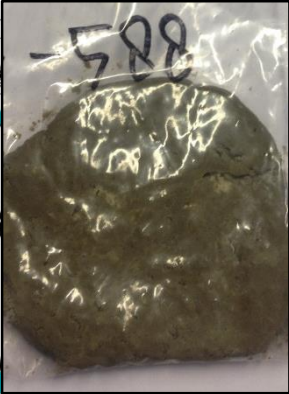
Lab Setup



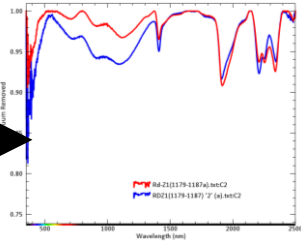
Field Setup

SAMPLE PREP

As is

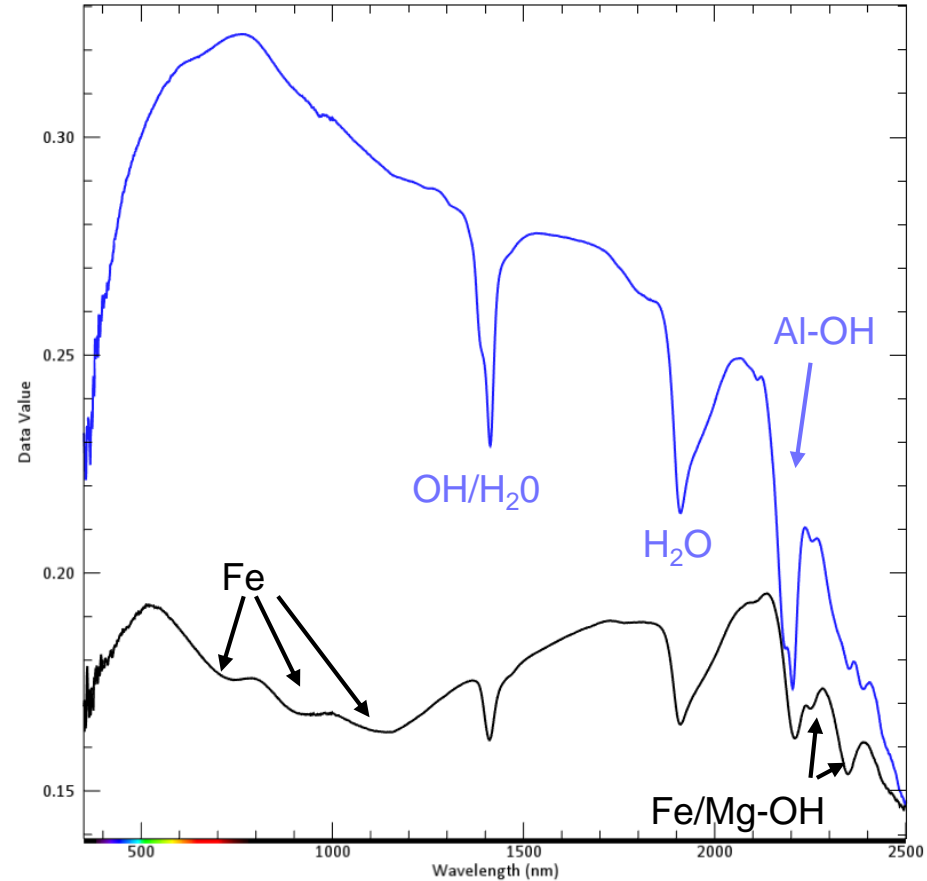


Washed



RESULTS - SPECTRUM

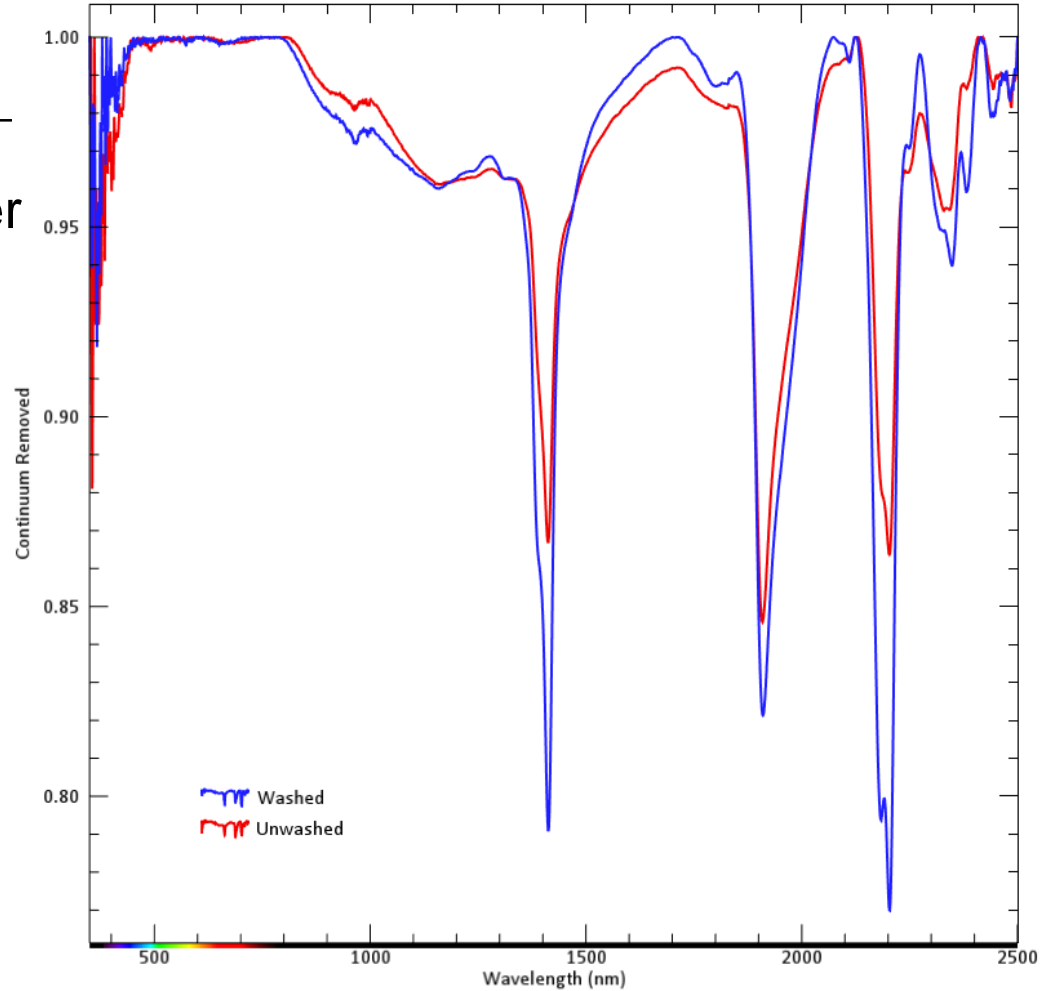
- Combination of features
- Transitional metals in VNIR
- Hydroxylated silicates and structural water in SWIR
- => interpretation in to minerals
- => mont, nontronite, ill, chl, halloy, ep, jar, carbonate



RESULTS - WASHING

- Washed: features deeper and more distinct
- But:
 - Difference small
 - still interpretable

=> Use washed for time being



SIMPLIFIED MODEL (EXAMPLE WELL)



50-350

- Montmorillonite (smectite) dominated.
- => Clay cap

350-550

- Distinctive change to Illite
- => Start reservoir?

550-762

- Chlorite –dominated (+- Mont?) section of reservoir (final depth ca. 2000m)

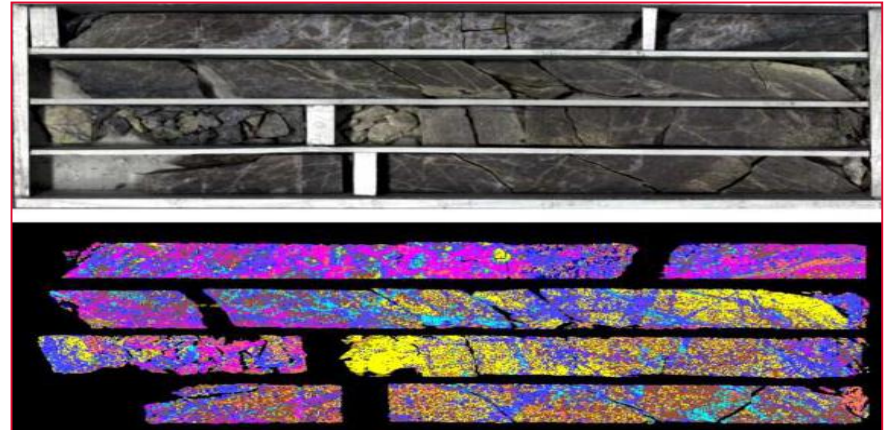


(CURRENT) CONCLUSIONS

- Dominating SWIR active minerals can be detected
=> Montmorillonite vs. Illite vs. chlorite vs. halloysite etc.
- Epidote and calcite not in many samples
- Other minerals (e.g. actinolite, wairakite ..) not detected yet
=> probably overpowered by clay signature
=> analysis of individual grains needed

NEXT STEPS

- Validation: XRD, XRF, wellsite geologist logs
- Look at small shifts
=> mineral chemistry
- Look at thermal infrared
=> Qtz, Fsp
- Infrared imaging
=> detect minor minerals



Automated mineralogical interpretation

Figure: specim.fi

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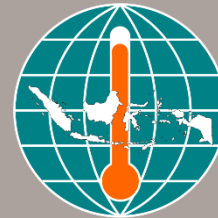
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