Remote detection of geothermal alteration from LiDAR return intensity data

Yan Restu Freski[1*], Christoph Hecker[1], Mark van der Meijde[1], Agung Setianto[2]

Findings in laboratory data (at 1550 nm)

- Altered rocks have higher LRI values than unaltered rocks.
- Moisture of the samples influences the LRI values: the moisture content decreases the LRI values.
- Wet, strongly altered rocks are less separable from dry, weakly altered rocks.
- However, wet altered rocks still have higher LRI than wet unaltered rocks.
- Therefore, LRI values can be used as a proxy to distinguish altered- from unaltered rocks, despite the moisture content.

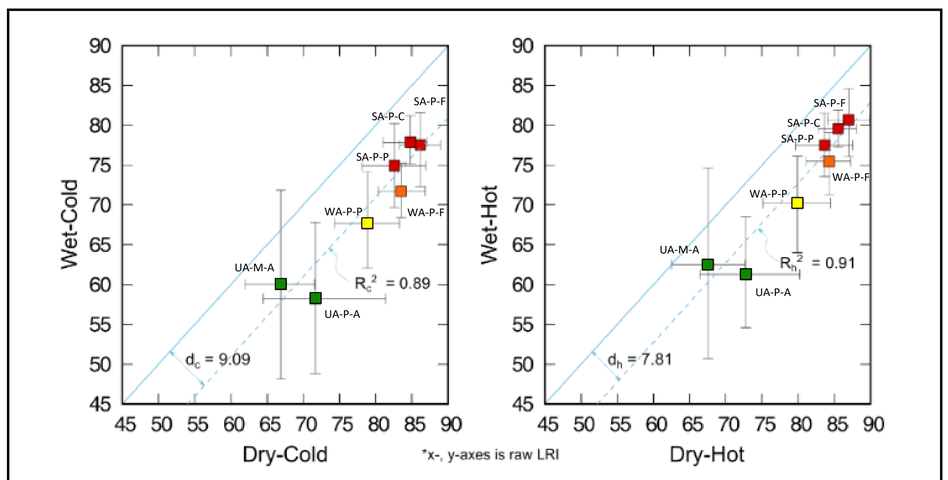

Fig 1. Plots of the LRI of the samples showing the trend of alteration degree despite the effect of sample moisture (modified after Freski et al 2021).

Findings in airborne data (at 1064 nm)

- Trends of LRI values are shown to be strikingly similar to the laboratory results for the limited area surrounding the sampling points, although the LiDAR wavelengths are different.
- Natural factors (e.g. terrain slope and aspect, soil wetness, and vegetation) might influence LRI values that interfere with the observed trend of alteration degree.

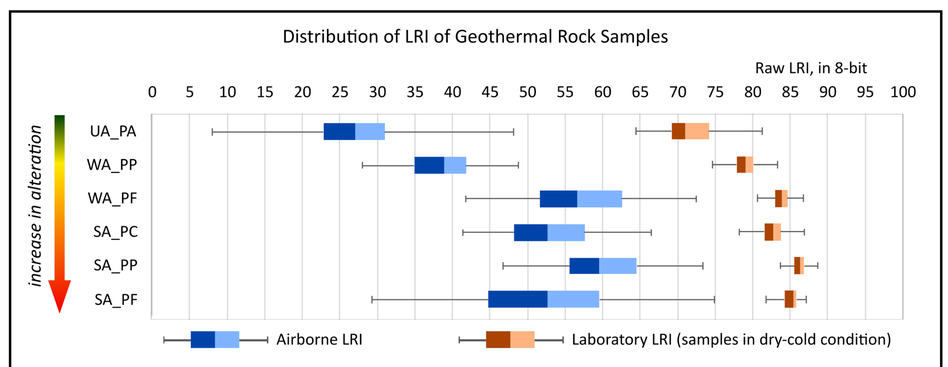

Fig 2. Plots of the LRI of the samples in laboratory data showing a similar trend to the limited sampling area of those lab samples in airborne data.

Outlook

These results open up the possibility of LRI application for airborne hydrothermal alteration mapping, although further data processing and additional information are required to improve the detection.

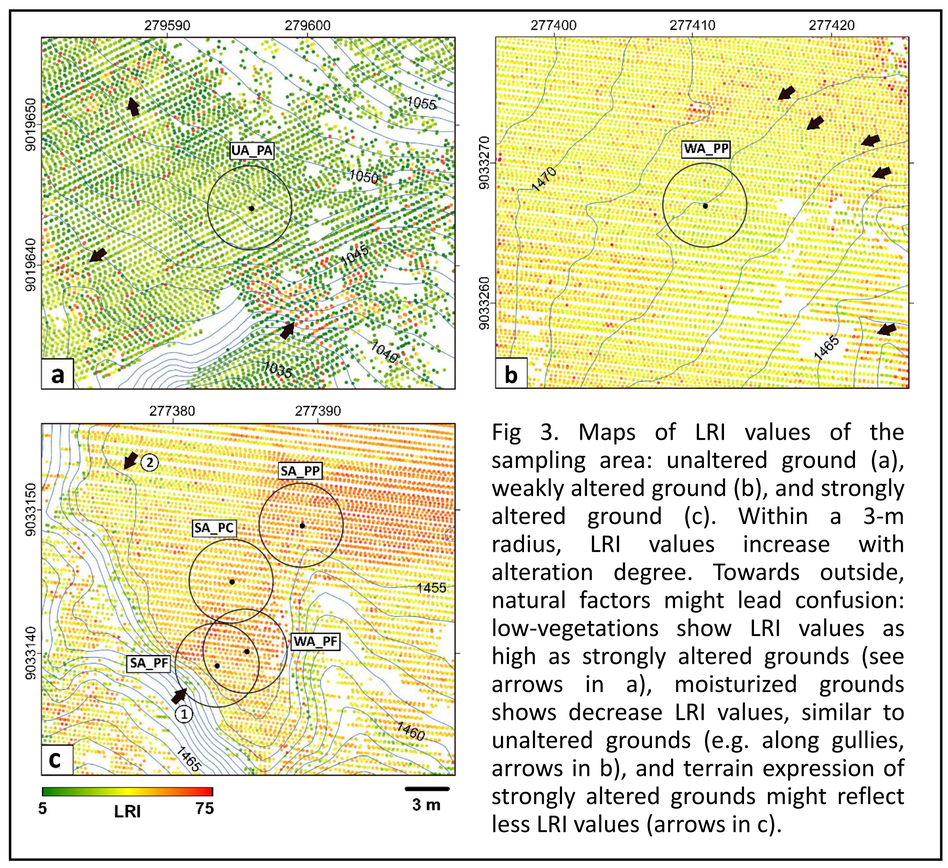

Fig 3. Maps of LRI values of the sampling area: unaltered ground (a), weakly altered ground (b), and strongly altered ground (c). Within a 3-m radius, LRI values increase with alteration degree. Towards outside, natural factors might lead confusion: low-vegetations show LRI values as high as strongly altered grounds (see arrows in a), moisturized grounds shows decrease LRI values, similar to unaltered grounds (e.g. along gullies, arrows in b), and terrain expression of strongly altered grounds might reflect less LRI values (arrows in c).

"As a new alternative in high-resolution remote mapping for geothermal surface manifestation, we can see alteration degree of rocks from LiDAR return intensity data."

Further explanation of our works:

"The effects of alteration degree, moisture and temperature on laser return intensity for mapping geothermal manifestations", *in Geothermics 2021*

Further information:

* Corresponding author: y.r.freski@utwente.nl

[1] Department of Applied Earth Sciences, Faculty of Geo-information Sciences and Earth Observation (ITC), University of Twente, Enschede, The Netherlands

[2] Department of Geological Engineering, Faculty of Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia