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Hyperspectral remote sensing exploration of carbonatite - an example from Epembe, Kunene region, Namibia

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Remote sensing data can provide valuable information about ore deposits and their alteration zones at surface level. High spectral and spatial resolution of the data is essential for detailed mapping of mineral abundances and related structures.
Carbonatites are well known for hosting economic enrichments in REE, Ta, Nb and P (Jones et al. 2013). These make them a preferential target for exploration for those critical elements.

In this study we show how combining geomorphic, textural and spectral data improves classification result. We selected a site with a well-known occurrence in northern Namibia: the Epembe dyke. For analysis LANDSAT 8, SRTM and airborne hyperspectral (HyMap) data were chosen. The overlapping data allows a multi-scale and multi-resolution approach. Results from data analysis were validated during fieldwork in 2014.

Data was corrected for atmospherical and geometrical effects. Image classification, mineral mapping and tectonic geomorphology allow a refinement of the geological map by lithological mapping in a second step.
Detailed mineral abundance maps were computed using spectral unmixing techniques. These techniques are well suited to map abundances of carbonate minerals, but not to discriminate the carbonatite itself from surrounding rocks with similar spectral signatures. Thus, geometric indices were calculated using tectonic geomorphology and textures. For this purpose the TecDEM-toolbox (SHAHZAD & GLOAGUEN 2011) was applied to the SRTM-data for geomorphic analysis. Textural indices (e.g. uniformity, entropy, angular second moment) were derived from HyMap and SRTM by a grey-level co-occurrence matrix (CLAUSI 2002). The carbonatite in the study area is ridge-forming and shows a narrow linear feature in the textural bands.

Spectral and geometric information were combined using kohonen Self-Organizing Maps (SOM) for unsupervised clustering. The resulting class spectra were visually compared and interpreted. Classes with similar signatures were merged according to geological context.

The major conclusions are:
1. Carbonate minerals can be mapped using spectral unmixing techniques.
2. Carbonatites are associated with specific geometric pattern
3. The combination of spectral and geometric information improves classification result and reduces misclassification.

References

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