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A hyperspectral remote sensing flight campaign in the VNIR-SWIR-TIR wave length for reconnaissance mapping of the BIFs of the Kaapvaal Craton

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A hyperspectral flight campaign in the Northern Cape, South Africa was carried out to spectroscopically describe the mineralogical/geological surface characteristics of major mineral deposits and their geological setting. This study focuses on the spatial mineral distribution of the Banded Iron Formations (BIF) in the southwestern Prieska sub-basin, Transvaal Supergroup, South Africa. The hyperspectral data were simultaneously acquired by three sensors to cover the visible light, the near infrared and shortwave infrared (VNIR-SWIR) and the long wave infrared (LWIR) with a spatial resolution of 2.5 m. In addition, LIDAR data were acquired to create surface and terrain models with a spatial resolution of 1 m for orthorectification of the hyperspectral data and to support detailed tectonic studies.

The geological inventory is characterized by granites (2.9 Ga), overlain with an angular unconformity by the 2.8 Ga andesitic - rhyodacitic, partly porphyritic lavas of the Ventersdorp Supergroup[1]. The Transvaal Supergroup follows unconformably with quartzites and lavas (2.64 Ga), shales, carbonates and two successive banded iron formations (BIF). These are the Kuruman BIF and the Griquatown BIF of Paleoproterozoic age. The carbonates and BIFs are intercalated with relatively thin but regionally extensive and uniform tuff beds. The sedimentary record in the region recommences with the upper Paleozoic glacial Dwyka deposits. Tertiary to recent calcretes, sands and alluvial and fluvial sand deposits cover the Precambrian and Paleozoic rocks [2].

The mineral identification is based on a multi feature extraction approach applied separately to the VNIR-SWIR and TIR data, combined with a spectral unmixing approach using a constrained least squares method to derive the dominant mineral components. Then these results were used for cross validation where applicable to minimize ambiguities. Finally, a synergetic information extraction from the spectrally derived mineral paragenesis by a context driven assessment of the results and a correlation with the geological setting, to characterize and identify deposits, was applied. The results are thematically discussed together with ground truth data, geological maps and multispectral analysis based on Landsat/Aster data [3, 4]. Spectral characteristics are investigated to describe and characterize in detail the mineralogy of the Kuruman and Griquatown BIFs, as for example the quartz and hematite/ goethite correlations in the Banded Iron Formation rocks.

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