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Red Green: Geochemistry of colored siltstones from the *Daptocephalus* (*Dicynodon*) and *Lystrosaurus* Assemblage Zones at Old Lootsberg Pass and Bethulie, South Africa

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Sedimentologic characteristics of colored siltstone play a central role in the current model of Changhsingian (late Permian) biodiversity turnover in the Karoo Basin, South Africa. These rocks, assigned to the Elandsberg and overlying Palingkloof members of the Beaufort Group, represent fully terrestrial deposits of fluvial and interfluvial landscapes initiated in the Middle Permian after Gondwanan deglaciation. As currently envisioned, siltstone in the *Daptocephalu*s (*Dicynodon*) Assemblage Zone is reported to transition stratigraphically from olive gray (Elandsberg Mbr.) to a mottled greenish and grayish-red color (Palingkloof Mbr.) and, ultimately, to massive grayish red, which is considered a feature of the superposed *Lystrosaurus* Assemblage Zone. This color change is interpreted as primary and has been hypothesized as a consequence of increased loessic dust contribution deposited across interfluves that was incorporated into laterally extensive semi-arid soils. To date, the hypothesis has not been tested geochemically.

Olive-green and grayish-red siltstone, collected from intervals in the Palingkloof Member at Old Lootsberg Pass and Bethulie where the biozone transition is reported, have been petrographically, mineralogically, and geochemically characterized. Samples represent both stratigraphically successive beds as well as their lateral equivalents, as determined from mapping and section measurement at both localities. Geochemical data were obtained using XRF, SEM-EDAX, and Mössbauer Spectroscopy.

Petrographic analysis of thin sections reveals the presence of primary sedimentary structures in both olive gray and grayish-red samples. These include sub-mm-scale beddings and evidence of bioturbation. Anisotropy of magnetic susceptibility (AMS) data from these rocks typically show primary depositional fabrics. XRF elemental compositional data show that olive-gray and grayish-red samples are not significantly distinguishable in any other major element, including iron. Iron concentration of whole rock samples range from 1.74 wt.% to 4.66 wt.%; whereas the clay-sized fraction of these samples contains 2.87–5.42 wt.% of iron. Clay mineralogy of the samples was determined using XRD and, regardless of color, the clay species present in all samples are only chlorite and illite. Mössbauer spectroscopy reveals that over 50% of the iron present in the rocks is ferric (Fe+3) in all samples. Where the two siltstone types differ is in the presence of hematite. More than 16% of ferric iron in grayish-red samples is in the form of finely dispersed hematite, while olive-gray samples do not contain any hematite. Under SEM, hematite and other iron oxides occur as micron-sized crystals or coatings on illite or chlorite, and semi-quantitative data, based upon EDAX analysis, indicate that these minerals also have relatively high concentrations of Ti. Other Ti-rich minerals including titanite, rutile, and ilmenite occur in grayish-red

siltstone, which also are responsible for their coloration. When these data are placed into stratigraphic and lateral context, color differentiation in the Palingkloof Member is interpreted not to be the result of detrital hematite introduced through eolian processes, but early diagenetic alteration of clay minerals in response to lateral variation in geochemical conditions in these sediments.