Reclamation of Two Kyanite Mine Tailings Ponds with Different Surface Topographies

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Extended Abstract

During the mining of kyanite from a pyritiferrous quartzite-kyanite ore body in Georgia, USA, several tailings ponds (TP) were created (Fig. 1); the largest were 31 ha (77 ac) (East TP (ETP)) and 10.5 ha (26 ac) (West TP (WTP)) (Fig. 2). The acidic interstitial water (pH < 2.7), coupled with the acid producing tailings, hindered site reclamation. A new surface topography was established in the TP materials by the installation of ridges and furrows (RAF) to create a surface for successful reclamation and improved surface water quality runoff (RO).

Successful test plot studies, coupled with tailings leaching studies, provided data for establishing a reclamation plan including RAF topography across the entirety of the ETP to divert most surface RO into vertical infiltration. The water table across the ETP varied from approximately 0.5 m (1.5 ft) below ground surface to being visible at the tailings surface. Initially, 0.15 m (6 in) of organic material (straw) was incorporated into the top 0.3 m (1 ft) of tailings and fine grained $CaCO_3$ was applied at rates of 90–135 Mt/ha (40–60 to/ac). Ridges, approximately 0.5 m (1.5 ft) high and 0.6 m (2.5 ft) wide with corresponding sized furrows, were created using farm equipment. The function of the remodeled topography was to allow for 1) ponding of freshwater precipitation RO within the furrows to displace the acidic near surface water and 2) leaching of acidity from the ridges, creating a more ecologically improved surface for vegetation. The RAF were further amended by aerial application of 673 kg/ha (600 lb/ac) of 10-10-10 fertilizer and seeded with an 11 seed mix. Lime and fertilizer were reapplied aerially for two seasons and vegetation successfully (> 90%) established in three years. (Caruccio et al. 1999). Improved surface water quality, plant succession from grasses and herbaceous cover to shrubs and trees, increases in soil carbon, and lowering of the ETP water table due to increased evapotranspiration, have occurred during the subsequent 20 years. (Geidel 2012; Geidel and Niles 2022).

The smaller WTP, had RAF topography installed in the lower ¼ of the WTP when additional tailings were added to the WTP; however, the remainder had been previously covered with a 5–10 cm (2–4 in) veneer of soil and previously reclaimed with limited success. Additional lime, fertilizer and seed were applied to the veneered section of the WTP simultaneously with and at the same rates as the ETP and were incorporated into the top 2–4 cm (1–1.5 in) of the veneer cover. While there was a substantial succession in grass and herbaceous species on the portion covered with a thin veneer of soil, there was no tree establishment in the portion of the WTP without RAF. The WTP section with RAF had a succession from grasses to trees and shrubs. Due to the lack of shrubs and trees on the majority of the WTP, it is suggested that the evapotranspiration was less than in the forested area.

The RAF surface topographic technique can be used to reclaim an acidic tailings pond with a high water table as indicated by: 1) successful growth of the planted species, 2) succession and invasion of volunteer species, 3) an increase in the pH of the RO water (from pH < 2.7 to pH 5.5–7.5) and 4) a decrease in the surface water discharge coupled with a lowering of the groundwater table as supported by a hydrologic study (Geidel 2012). In the WTP, without RAF and only a surface veneer of soil rather than incorporated mulch and changed topography, similar results were

obtained related to decreased RO; however, while there was substantial succession in grass and herbaceous species, there was no tree establishment in that area without RAF even after 20 years.

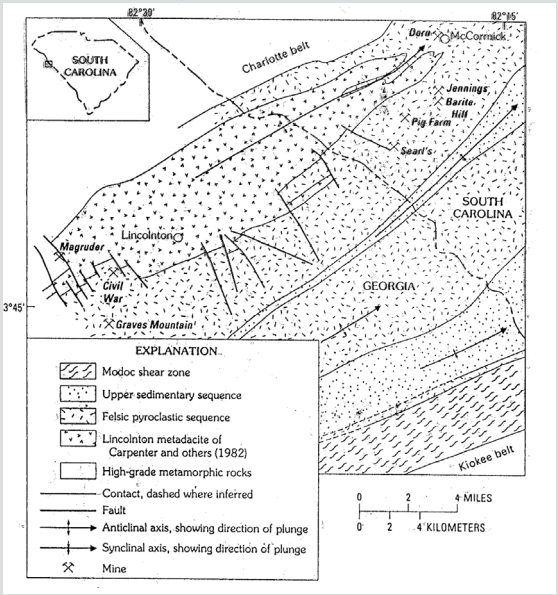

Figure 1 *General Geology in the vicinity of the Graves Mountain, GA mine site (west central location on map). Adapted from Butler and Secor 1991*

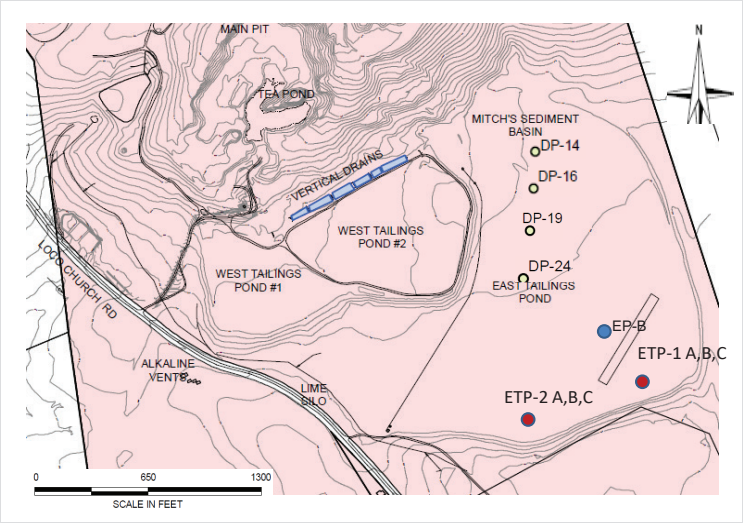

Figure 2 *Outline of the East (ETP) and West (WTP) Tailings Ponds*

Key Words: Acid mine drainage, acid rock drainage, hydrology

Acknowledgements

ABB, Inc. is gratefully acknowledged for the funding and support for the above studies.

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