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Soil and vegetation recovery in reclaimed post-surface mine landscapes

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Reclamation following mining activities aims to restore ecosystem properties including stable soils that support productive and diverse native plant communities. Complete recovery of a mined ecosystem depends on the recovery of belowground properties, i.e. the physical, chemical, and biological aspects of the soil. Recovery of soil microbial communities are of particular importance due to their influence on grassland plant community composition, and mediate most soil processes that affect nutrient availability, plant health, and primary production. The post-mining soil re-spread process increases soil compaction, reduces water infiltration, and restricts plant species recruitment and diversity patterns on reclaimed landscapes, which do not improve over time unassisted. However, the status of soil microbial communities and microbial activity changes that occur over time in post-mined landscapes are largely unknown. Given the strong link between stable and productive plant communities and soil microbial communities, it is critical that we understand soil microbial community dynamics in post-mine landscapes. Therefore, we surveyed permanganate oxidizable carbon (POXC) and microbial biomass carbon (MBC) as well as soil chemical and physical properties, and plant community composition on 14 reclaimed landscapes over a 42-year chronosequence. Post-mining disturbance affected all soil properties at all stages of recovery over a 42-year time-since-reclamation chronosequence. Soil organic carbon was roughly half that compared to reference soil carbon levels even 42 years post-reclamation. MBC soil was consistently less than the reference site. Moreover, the soil of the oldest reclaimed year contains almost half of both the MBC and POXC compared to the reference site. Plant communities in older reclaimed sites were dominated by exotic grasses (72% relative cover) with limited native grass and forb components. The goal of reclamation is to return an ecosystem to pre-disturbance productivity and diversity levels. Strong linkages between land management strategies, soil properties and vegetation composition can advance reclamation efforts and promote heterogeneous landscapes. However, our results demonstrate the need to incorporate a more robust restoration program because almost all soil measurements of reclaimed sites were different from the reference site. Further, this suggests that post-reclamation management strategies are critical to determine ecosystem recovery outcomes and that homogeneous land management may lead to decreased landscape-level diversity.