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Contributing towards a conceptual model of soil-landscape co-evolution: observations from historic mining sites in Alberta, Canada

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At the former Diplomat Mine near Forestburg, Alberta, Canada we find a diverse soil landscape which can help to conceptualize factors and processes controlling initial pedogenesis and soil distribution on very young landforms in prairie environments. Due to differing reclamation practices in the 1950s and landslides occurring after spoil dumping, four areas can be distinguished by GoogleMaps/LiDAR evaluation and onsite field survey: (i) not-mined, (ii) stock piled and unreclaimed, (iii) stock piled and reclaimed and (iv) affected by post-mining geomorphodynamics and quasi-natural redeposition.

The parent material for areas (ii) to (iv) was initially dumped by spreaders but only (ii) didn't undergo further change. Landscape (iii) has seen levelling of the piles by heavy machinery. Features of landscape (iv) are formed by reshaping the originally dumped and levelled structures. This last landscape unit marks the rim of the former mine adjacent to the river valley. In practice, mining activities formed new valley slopes. In contrast to the naturally developed slopes the mine slopes were less stable. Vegetation, which could have hindered slope wash erosion, was missing after dumping the spoil slopes. Slopes were very steep (or practically undercut) and therefore, substrates were naturally re-located by mass movements such as sliding and slumping. Characteristic sliding and slumping structures can be identified in the close-ups of the LiDAR images. Both processes, mass movement and slope wash erosion, may have overlapped. Landscape (ii) is the most contrasting one. Dumped stock piles formed elongated, curved and steep ridges. These landforms do not have a natural analogue but clearly show their technological origin. Most interesting are differences in vegetation. South and southwest facing slopes are covered with grassland whereas north and northeast facing slopes are covered with aspen trees. Some of the ditches are filled with water and form small elongated ponds. The characteristic geomorphology of the prairie can be found in landscape (i).

Distinct differences are found in properties and types of soils in these four landscapes. Natural soils and pile soils characteristically differ in parent material and soil horizons. No information is gathered yet for the reclaimed soils and the landslides soils due to prohibited access. However, based on what we find at the former Diplomat Mine we can conclude that distribution, development and properties of unreclaimed soils in historical open cast mines in Alberta are primarily controlled by parent material and topography. The geomorphological set-up is dominating the trajectory of vegetation development and post-mining geomorphodynamics. Contrasting slope aspects determine micro climatic conditions and lead to different vegetation types. This has likely had an effect on soil development and soil properties (especially carbon stocks). Further studies will be conducted to quantify these differing soil properties to refine this conceptual model of initial pedogenesis and soil distribution on very young landforms in the prairie landscapes.