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Occurrence and formation of kaolinite-smectite mixed-layers in 'red and black' soilscapes: a case study from south-western Ethiopia.

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The relationship between red and black coloured soils in the so-called 'red and black' soilscapes in humid tropical environments has been well documented in the literature. This change in colour is especially striking because it is linked with the landscape position: red soils in the highlands and black soils in the lowlands. The obvious change in colour is also associated with a change in the clay mineralogy: from a mixture composed mostly of iron oxides and kaolinite to one dominated by smectitic minerals. These soilscapes are also more commonly observed in areas where igneous and volcanic rocks occur as parent materials, since these provide the necessary physico-chemical conditions for the formation of smectites. As the parent materials become more intensely leached, the mineralogy becomes dominated by kaolinite and iron oxides, giving rise to the red coloured soils, while smectites either elluviate and accumulate or crystallize directly from the soil solutions in the lower landscape positions.

Several accounts have been made of the occurrence of kaolinite-smectite mixed-layer minerals in such red and black soilscapes, even though these mixed-layers are not regarded as a common soil mineral constituent. Often these mixed-layer minerals are considered to be an intermediate product in the mineralogical evolution of these tropical soils. However, the exact processes involved in its formation are still a source of debate. A better understanding and documentation on the conditions under which these mixed-layer minerals are found might improve our understanding.

Recent mineralogical analyses of soil profiles located in the Gilgel-Gibe catchment in south-western Ethiopia revealed the clay fraction of 'black' Vertisols and Vertic Planosols to be dominated by kaolinite-smectite mixed-layers. Specific chemical extractions suggest that kaolinite layers are more actively being formed from the soil solution in better-drained topsoil horizons compared to more poorly drained subsoil horizons. It was also shown that the subtle differences in clay mineralogy can be related to contrasting pedological conditions within a soil profile. This indicates that the formation of kaolinite is governed primarily by the intensity of leaching, both at soilscape level and at pedon level.