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Role of mineralogy and particle-size distribution on patterned ground genesis in no-permafrost soils. Majella massif (Italy) and English Lake District (United Kingdom)

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Patterned ground soils form by self-organization thanks to soil heaving caused by seasonal variation of ice table, but also in no-permafrost affected soils thanks to diurnal or seasonal freeze/thaw cycles. The genesis of the superficial soil pattern is thought to be due to cryo-selection of the skeletal particles, which is induced by freezing/thawing cycles of the water present in the saturated active soil layer. Other conditions required for the formation of a patterned ground are: moderate to null slope, scarce vegetation and the presence of a sufficient amount of fine materials (fines). If all this attains, the stones are easily pushed out the freezing area, so producing sorted features where skeleton and fines are rather segregated. Patterned ground soils were described in a wide range of no-permafrost affected environments. Here, we report on the role of soil mineralogy and particle-size distribution in the genesis of patterned ground in two sites where permafrost is some meters deep (Majella massif, Central Italy) or absent (English Lake District, North West England). Majella massif (Monte Amaro, 2793 m a.s.l.) is at 42° North of latitude and is mainly composed by limestone, while English Lake District (Scafell Pike, 978 m a.s.l.) is at 54° North of latitude and is mainly composed by laminated mudstone and siltstone. Patterned ground soils described on the Majella massif are smaller than those at English Lake: the sorted circles of Majella massif have a diameter of about 5-7 cm while those of the English Lake have a diameter of about 15-20 cm.
In each site several soil profiles were dug till about 1 m of depth, described and sampled according to the recognized horizons. All the soils are well drained thanks to high skeleton content (60 to 80%), which is also responsible of preventing soil saturation. The results of mineralogical and particles-size analysis show that the formation of a saturated active layer is possible thanks to the formation of an ephemeral, impermeable and sub-superficial frozen-earth table, which form when fine earth has a high water retention because of a high content of silt and clay and a relatively high content of clay minerals with 2:1 structures (smectite, vermiculite, HIS, HIV). The high content of skeleton allows the soil to freeze from the surface because of two reasons: 1) the thermal conductivity of the stones is greater than that of the fine earth, and 2) the presence of a high content of skeleton favours the circulation of cold air in the ground. Because of this, in no-permafrost affected areas, even small variations of seasonal weather conditions may strongly interfere with the annual formation of the sub-superficial frozen-earth table, so causing the deterioration and even the disappearance of patterned ground in turns of some years.