# 3D topological relationships of landforms and their Spatial Schema based representation

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**Abstract**

The science of geomorphology works on natural 3D landforms. Research includes the change of landforms as well as the processes causing these changes. Material transport processes lead to a composition of a geomorphic system that follows a certain spatial hierarchy. The analysis of 3D topological relations of landforms can help to investigate geomorphic systems in two ways. First, chronological order of geomorphic genesis can be derived and, second, indications of material source can be found. However, at least some 3D geometric information is needed if topology is supposed to be derived and examined.
Landforms cannot simply be reconstructed by surface measurements. Data capture is a major if buried features are under investigation. Subsurface information is gathered by drillings or geophysical methods that reveal point or line information. Unfortunately, the ISO 19107 Spatial Schema does not offer a valid representation of 3D geometry from sparse data, either by aggregating a surface and one or few points or by aggregating a surface and a line.

Here, we discuss the possibilities for the analysis of chronological order of landform genesis and material dependencies that arise from applying 3D topological relationships to geomorphic system analysis. We show five relationships that are able to be observed in nature. Further, we introduce a new class for the representation of 3D objects with underspecified geometry. An *_UG_Solid* mediates between the Spatial Schema's geometric primitives with a dimension less than three on the one side and a *GM_Solid* on the other side. Constraints to aggregate such an *_UG_Solid* are defined. The introduction of an *_UG_Solid* facilitates the application of 3D topological concepts to geometric objects that are known to be volumetric but have to be modelled from sparse data.