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# Variations in the morphology of reactivated fault scarps in the UK

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Reactivated faults scarps have been documented throughout the United Kingdom (UK) generated during coal mining subsidence. However, some fault scarps, such as those located on the interfluves and moorland plateaux in the South Wales Coalfield and the Namurian sequences in the Pennines (where mining has not taken place) may have been initiated during valley deglaciation in the Pleistocene, whereby, stress relief and gravitational rebound and lateral spreading of the valley sides followed, or occurred simultaneously with, the retreat of glaciers. However, this is somewhat difficult to prove and geological evidence is still being sought to prove this theory. Other fault scarps, such as those in northern Scotland have also been interpreted to have been induced by palaeoseismicity associated with the retreat of ice sheets. This paper presents details of the variations in the morphology of reactivated fault scarps, which have been observed by the authors over a period of approximately 25 years. This paper also explores why fault scarp morphology is variable. When considering fault scarp morphology scale is also relevant. For example, scarps can appear as a single dislocation on aerial photographs but may comprise multiple smaller dislocations and sub-scarps when observed on the ground (*the Russian Doll Effect*). Faults scarps vary considerably and can be traced along the ground surface as a single dislocation or as a zone of multiple sub-scarps. They can vary from less than 0.1m to over 4m high, and from a less than a metre to several kilometres long across moorland slopes. Furthermore, fault scarp displacement may be vertical (usually 'normal', but sometimes 'reverse'), lateral (strike-slip), compressional or dilatational, resulting in the generation of compression humps or fissures, respectively. Fault scarps may be linear or sinusoidal and they may diffract and reflect along the ground surface (Figure 1).

Figure 1 Variations in fault scarp morphology: (Left) Uphill facing, linear, fault scarp above the crest of Troedrhiwfuwch landslide, South Wales, UK. (Middle) Two parallel scarps, Tableland Fault scarp, South Wales, UK. (Middle) Small graben, Derbyshire, UK.

Fault scarp morphology seems to be dependent on several interrelated factors. For instance, those related to mining subsidence will be influenced by the depth, width, type, age of past mining and numbers of worked seams. The type, thickness and engineering properties of superficial deposits or made ground significantly influences fault scarp morphology. Faults that crop out in strong rock, such as Pennant Measures or Coal Measures Sandstone, Permian Limestone or Sandstone or areas of concrete

hardstanding, macadam roads or paved areas tend to have more distinct, steeper morphology. Faults that outcrop in weaker granular or cohesive soils have a less distinct scarp over a broader area up to several metres wide. In urban and agricultural areas reactivated fault scarps tend to be temporary features of the landscape. Soon after their generation they may become degraded by anthropogenic activities such as ploughing, road and structural repairs or building and construction. By comparison, in areas of higher relief and relatively remote parts of Wales, Scotland and the Pennines some of the fault could be tens to thousands of years old. However, this remains speculative and further research is required to accurately and invasively investigate, map, record and date the origin of these fault scarps to better understand their origin and evolution.