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Spontaneous initiation of debris flow surges from sedimentary deposits

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We report here that a small gully of sedimentary deposit has spontaneously produced a sequence of debris flow surges in great variety of appearances. The event occurred in a tributary gully of 0.16km², without slope failures and rainstorms; the only triggering force was the groundwater at small discharge (0.5L/s). Individual surges originated separately from the sediment in different manners and appeared in a variety of flow regimes and material compositions(Fig.1). We've taken a detailed scrutiny on the whole processes, i.e., the surge sequence spontaneously occurring in the stream (Fig.2), and suggested a mechanism for the surge scenario. It is proposed that the sediment is heterogeneously composed of blocks of granular aggregates, featured by the grain size distribution (GSD). With different GSD parameters, sediment blocks have different critical condition of liquefaction or fluidization, which determines the manner of surge initiation (Fig.3). Fine grains are easily to run out with infiltration to form slurry and lubricate the substrate sediment layer, facilitating the mobility of succeeding surges; while coarse grains collapse as Coulomb failure and turn into high concentrated surges. And variation of the substrate granular structure causes on and off of the surges. In summary, it is the randomness of GSD and block of sediment that lead to the variety of surge initiation; and the initiation and motion of tributary surges provides a vivid scenario for intermittent surges in the mainstream channel.