
A 3D rule-based model implemented on 7.5' DEMs has been used to study erosion/deposition processes on Cima Dome and in the Cima Volcanic Field, southeastern California. Discrete, sediment-carrying water-particles, similar to the "precipitons" used by Chase, are routed across the land surface. This method is equivalent to solution of a nonlinear 3D diffusion equation. Model stability is expressed as a relation between spatial and temporal resolution, as in classical diffusion. Unphysical pits in raw DEM data are removed by sediment deposition. Terrace-like artifacts due to DEM rounding errors are smoothed by application of a topographic annealing schedule. Water-particles are treated as emergent variables whose characteristics are quantified by comparison to large spatial-scale and long time-scale system behavior.

Water-particle properties and surface detachment rates are chosen to reproduce the observed magnitude of typical surface channelization (slight) and of average overall pediment erosion rates in the Cima Dome area as measured by Dohrenwend and others. Straight to slightly concave-up downslope profiles are maintained over time (m.y.) while average gradient decreases slowly as erosion of the upper dome surface proceeds. Major incision and canyon-cutting associated with the presence of capping basalt flows of known age are treated within the model. Water-particle rules developed and calibrated for one portion of the Cima area are applied to the remaining portion to test how well the model can be applied to areas for which it was not directly calibrated.

The model has also been applied to the study of short-term trends (years to decades) of erosion/deposition, as indicated by field evidence from artificial disturbances of known age such as dirt roads. The braid-like behavior of flow on the dome surface suggests that even deep artificial furrows oriented downslope will eventually be filled in with alluvium and erased. Applications of the model over short-time scales is of potential interest for purposes of land use management and environmental planning in arid terrain.