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Determination of morphometric parameters of scoria cones in San Francisco Volcanic Field (USA, Arizona)

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The publication of the Digital Terrain Model of Shuttle Radar Topography Mission (Farr et al., 2007) has revolutionized a number of fields in volcano-geomorphic research. Its high-resolution data (especially in the area of the United States) make it possible to analyse smaller landforms that previously were typically excluded from morphometric analyses.

Our study area, the San Francisco Volcanic Field (SFVF), is a ca. 4500 km^2-large volcanic region situated around the San Francisco stratovolcano at Flagstaff, Arizona (USA) that hosts some 600 scoria and lava domes, numerous lava flows with extensive pumiceous and volcanic ash deposits. The morphometric parameters of the numerous volcanic cones have been studied by several previous workers. In his pioneering work of Wood (1980) considered 40 scoria cones, while almost two decades later Hooper and Sheridan (1998) included 237 features in their study. Their manual morphometric analyses based on topographic maps that are time consuming, therefore their limited scope should be now extended with the availability of digital data.

We analysed 316 scoria cones in our study including all the evaluated volcanic features of the aforementioned authors. The parameters derived from the ca. 30 m resolution digital elevation dataset are mostly of the classic Wood (1980) parameters like H_{co} (height of the cone), W_{co} (width of the cone), W_{cr} (width of the crater, if applicable), etc.

Furthermore, we have evaluated the slope angle histogram for each feature, calculating the maximum and the average slope angles. All calculated morphometric parameters were evaluated then in the light of the ages of the volcanic cones in order to compare the behaviour of the various age groups and to derive the effect of the erosion on these parameters.

The members of the Late Pleistocene – Holocene group (0-0.16 Ma) have typically a closed crater, are 200 m high in average and have a steep 25.7˚ average slope, and characterized by 0.109 (+/- 0.024) H_{co}/W_{co} ratio. Their Middle Pleistocene counterparts (0.16-0.73 Ma) have 0.090 (+/- 0.017) H_{co}/W_{co} ratio and 20.5˚ mean slope angle. The other end members, reaching only 87 m height, the Pliocene cones (2.48-5.0 Ma) have only 0.061 (+/- 0.015) H_{co}/W_{co} ratio and 12.2˚ slope angle.

In conclusion we found that all analysed morphometric parameters (height of cone, height/diameter ratio, slope angle and diameter) decrease with the increasing age, but the decreasing rate of the diameter is the lowest. In the correlation analysis of the various parameters it turned out that there is a strong correlation between the depth of the crater and the width of the crater, that is, there is a typical slope angle within the craters. This typical slope angle is steeper than the slopes of the volcanic cone outside (sometimes considerable) since the H_{cr}/W_{cr} ratio is larger than H_{co}/W_{co}.

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