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SPRING TUFAS AND CEMENTED SLOPE DEPOSITS IN GORGES OF THE WESTERN NORTHERN CALCAREOUS ALPS, TYROL: AN INTERIM OVERVIEW

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In gorges of the western Northern Calcareous Alps (Tyrol, Austria), local spring tufas and associated cemented slope deposits correlate with both a vegetated drainage area beside the gorge and presence of (quasi-) perennial springs. Within the range of gorges observed, depth and length of gorge incision, drainage area, mineralogy of the carbonate rock substrate, and exposition all do not to exert an influence on tufa formation.

A total of fourteen gorges (status May 2001) incised into Triassic to Jurassic limestones and/or dolomites were checked. Several contained sizeable spring tufa formations and, locally, associated cemented talus or colluvium. A cross-check indicates that, aside the formation of spring waters supersaturated for calcium carbonate, the single most important factor for tufa formation is the presence of a (quasi-) perennial spring or sap. Presence of tufa-precipitating springs appears to be controlled by the permeability of the substrate, combined with conditions favouring the formation of spring waters supersaturated for calcium carbonate, such as water retention within vegetated soil.

Gorges flanked by barren rocky slopes or that bear a thin, patchy soil cover are devoid of tufas, irrespective of slope height. There, near the gorge base, dissolution of rock carbonate is common at saps, and typically produces small half-caves. Gorges with a vegetated, soil-covered flank drainage area, by contrast, are favourable settings for the formation of spring tufas. Tufa-precipitating springs or saps may discharge from soil-covered drainage areas very small, provided that the spring discharges over all or most of the year. The soil cover of vegetated flank drainage areas provides both water retention, enrichment with CO_2 and, as a consequence, enhanced calcite dissolution within the soil and in the underlying carbonate rock. In some of the gorges with spring tufas, glacial diamicton is present in the flank drainage area. The diamicton may promote both retention of water in the soil and provide a source for dissolved calcium carbonate. The tufas and their associated deposits typically are confined to, or dominantly present on, one flank of the gorge; this reflects combined controls such as tectonic structure, local geology and hydrology, and soil/vegetation cover.

The tufas are present as (a) perched springline moss tufas and microbial tufas that may be situated well-above the gorge base, and/or (b) as waterfall tufas (phytoclastic tufas, moss tufas, microbial tufas), and (c) as macrophyte tufas and/or moss tufas largely concealed below vegetation cover ("concealed tufas") closely above the water table of the gorge stream. Microbial tufas are characterized by a relatively even to botryoidal to digitate surface covered by organic mucus. Locally, spring tufas at least 1 meter thick are present, and comprise the cement to talus boulders up to a few meters in size. At one location, below a spring formed by excavation in 1966 of an artificial rock wall, moss tufa and microbial tufa precipitated; the moss tufa accreted at a minimum average rate of 5–8 mm/a.

The spring tufas are locally associated with talus or colluvium cemented by isopachous to microstalactitic crusts of calcite. Cemented talus aprons associated with spring tufas may be up to

at least 8 meters thick, and are locally incised by the present gorge stream. Spring tufas and associated cemented slope deposits thus provide a record of Alpine gorge development. Small occurrences of spring tufas are much more common than suggested by literature, but comparatively large tufa formations (including hitherto undescribed occurrences) are rare. All spring tufa formations found within gorges are presently active; no unequivocal example of inactive (subfossil) spring tufa has been found. Comparing documented rates of spring tufa formation with the thickness of the observed tufa formations suggests that at least most of them (and at least part thereof) may be up to only a few hundreds of years old.

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