Decay of building materials in the Circular Mausoleum, Necropolis of Carmona, Spain

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The Necropolis of Carmona (Seville, Spain) is one of the most significant Roman burial sites in southern Spain used during the first and second centuries AD. Of its more than 600 tombs, the Circular Mausoleum is one of the best examples of a tomb affected by different decay mechanisms. The alteration patterns are varied and abundant, including host-rock fragmentation, loss of materials (disintegration, arenization), surface modifications (efflorescence, crusts of various typologies) and biological colonization (mainly bacteria, algae and lichens). As a result of the numerous interventions and restorations since its discovery, the tomb presents a high RH degree (78.9%, on average) and a general overheating near roof surface (mean temperature of air-rock interface remains 1.2°C above average air temperature). Moreover, vapor condensation is highly enhanced due to porous structure of stuccos, mortars and host-rock, thus condensation is registered during more than 20 days per month and it reaches monthly amounts up to 1.6 kg/m^3 air (January and February). These factors produce a thermal gradient in the tomb and, therefore, a stratification of the tomb air. Ventilation is restricted and the intense thermohygrometic gradient induces decay mechanisms through the tomb. Thus, biological colonization is mainly produced in areas near the ground, crusts in the intermediate zones and efflorescences and breaks out in the upper zones and roof of the tomb. Crusts and efflorescence are mainly composed of gypsum and are distributed in all kind of substrata. Crusts present different forms from thin, smooth and cryptocrystalline to globular crusts. Efflorescences show mainly acicular habit. Evidence of microbial activity is varied and widely extended. In the entrance and corridor walls, lichens, algae, cyanobacteria and heterotrophic bacteria are found. Inside the tomb the distribution of the microbial colonies depends on the orientation of walls and its distance to the entrance. Microbial colonization is more intensive in holes and rough substrates and presents a greenish color due to the growth of phototrophic microorganisms. In flat substrates, violet, and discrete black (spotted/mottled) colonies and dispersed green biofilms are found. The different pathologies observed are discussed to the light of environmental parameters.