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Urban decay of trachyte: correlating crust composition with air quality

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Decay of trachyte in the urban built environment was investigated on the Renaissance city walls of Padua, in northern Italy. They were raised by the Republic of Venice Serenissima in the 16th century for defending its most important mainland center, using trachyte of the Euganean Hills as building stone, a subvolcanic porphyritic rock quarried nearby.
Weathering crusts and patinas were sampled on trachyte exposed surfaces and analyzed by optical microscopy, SEM, EDS mapping, XRD and LA-ICPMS, in order to determine their mineralogical and microstructural features, and major- and trace-element chemical composition. The results were placed in direct correlation with quantitative environmental parameters, in particular concerning air quality and anthropogenic emission of pollutants, either measured or modelled. Influence of the specific composition of trachyte and other neighboring materials was explored as well.
The weathering layers on trachyte turned out to be mainly originated by exogenous processes. The enrichment in carbon and heavy metals (lead, arsenic, chromium, nickel, cadmium, antimony, bismuth etc.) is traced back to deposition of particulate matter from road traffic and domestic combustion of woody biomass; a secondary source is industrial processes in Padua and Venice-Porto Marghera, one of the biggest coastal industrial zones in Europe. The crystalline matrix of the crusts and patinas is typically formed by carbonates, especially calcite: since their concentration is negligible in the host rock, their near-surface abundance can be explained mostly by leaching of calcium from neighboring lime-mortar joints, and its mobilization and reprecipitation on trachyte according to local pH fluctuations. It is worth noting that the calcite layers may even promote growth of gypsum crusts, but their occurrence is seldom though. The sole significant intrinsic factor of trachyte alteration is related to dissolution of iron from biotite and other Fe-bearing phases, which then migrates to surface forming brown-reddish patinas. Generally, composition of the weathering crusts and patinas of Euganean trachyte proves to be an informative marker for the relevant environmental conditions and their evolution.