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Intrusive sheets and sheeted intrusions at Elba Island (Italy)

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Igneous activity at Elba Island (Tuscany) during the Late Miocene led to the emplacement of several magma bodies over a time span of about 1 Ma. Intrusive processes unfolded in two main cycles. The first one is represented by the successive emplacement of nine shallow-level granite porphyry layers connected by feeder dikes, eventually building up three nested Christmas-tree laccoliths. The laccolith layers were emplaced at depths between 1.9 and 3.7 km, and space for magma was created by roof uplift. The second cycle led to the build-up of the Monte Capanne pluton, closely followed by emplacement of a mafic dyke swarm. The pluton was constructed over a very short time span by three magma pulses stacked downward as subhorizontal intrusive sheets. The top of the intrusion reached a depth of about 4.5 km, and space for magma was created by roof uplift and tectonic-gravitational displacement of the overburden.

The laccolith intrusive layers are 50 to 700 m thick, with diameters of between 1.6 and 10 km. Length to thickness relationships for these individual layers show a power-law correlation that has been interpreted as the frozen evidence for the occurrence of a vertical inflation stage during laccolith growth. Also the reconstructed original dimensional parameters of the three intrusive sheets of the Monte Capanne pluton display a power-law correlation indicative of a vertical inflation stage during pluton growth under different physical constraints. Once the sheets constituting the two major Christmas-tree laccoliths and those of the Monte Capanne pluton are amalgamated in a single sheet (virtually for the laccoliths; actually observed for the the pluton), their

dimensional parameters fit the predicted value for a single larger pluton.

The laccolith layers failed to become larger plutons/laccoliths with typical dimensions likely owing to the large availability of magma traps in the crustal section they intruded (a fault stack of bedded turbidites) that inhibited the coalescence of magma batches. On the other hand, the prominent physical discontinuity exploited for the Monte Capanne pluton build-up (a major thrust between mountain-building tectonic units) directed three pulses of magma into a single reservoir, eventually building a successful pluton.

As a final consideration we can thus speculate that laccoliths and plutons represent different outcomes of the same geological process that formed laccoliths when magma failed to amalgamate in a single, thicker body, i.e. a successful pluton.