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Mechanism and duration of plutonic processes in oceanic crust: the example of the South Rallier du Baty intrusive complex, Kerguelen Archipelago

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The Kerguelen plateau was initiated by a large-scale tholeiitic-transitional magmatic episode. The rocks of the Kerguelen archipelago, dominated by basalts, record an evolution from this early transitional magmatism to Kerguelen plume-related alkaline magmatism. The latter is characterised by a wide range of volcanic and plutonic rocks from basic to differentiated felsic rocks, which outcrop at different locations in the archipelago but are especially abundant in the southwest of Kerguelen archipelago. This is the location of outcrop of the South Rallier Du Baty Intrusive Center (SRDBIC) which constitutes the largest plutonic body, classically interpreted as a cauldron.

The SRDBIC is an elliptical plutonic body of 13 by a minimum of 17 km with a N100-110 long axis. The rock composition range from gabbro to quartz rich-syenite and define a typical alkaline oversaturated magmatic serie. The contact is generally outward dipping but we have identified two contrasting geometries: one steeply dipping and crosscutting the basaltic lava flows, the other more shallowly dipping and concordant. At the scale of the Kerguelen archipelago, the orientation of the basaltic lava flows constituting the wall-rocks of the SRDBIC is very regular but is not strictly horizontal, showing a low dip (3-5°) toward the SE, due to recent tilting. We observe a change in this orientation when approaching the SRDBIC: all around the east and south margins of the SRDBIC, we measure a progressive tilting of the plateau basalts, reaching dips of 20-40° away from the SRDBIC. The amplitude of this tilt suggests that the thickness of the SRDIC is between 2.5 and 3.5 km, defining a total volume of 200-400 km3. The spatial coincidence between this change in basalt orientation and the intrusive centre clearly shows a causal relationship related to uplifting of the plateau basalts during the formation of the SRDBIC. Field observations and fabric studies show that the plutonic complex was formed by intrusions of successive magmatic injections. LA-ICPMS U-Pb dating of separated zircons shows the entire SRDBIC emplacement occurred over approximately 4 Ma, between 12 and 8 My. Our data show consequently that the SRDBIC was built at an averaged rate comprised between 10-4 and 5.10-5 km3.yr-1. All these new data lead us to propose a new emplacement model for the SRDBIC. We interpret it as a laccolith formed by successive magmatic injections inducing roof-uplift, similar to those forming many upper-crustal continental plutons, but in an oceanic within-plate setting.