Mode of emplacement of shallow igneous bodies in the Malargüe fold and thrust belt, Mendoza

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It is considered that the rheological contrast between strata and tabular igneous bodies exert an important control on the emplacement and shape of magmatic bodies (Menand, 2011; Thomson and Schofield, 2008). Field observations and laboratory experiments regarding the location of sills and laccoliths indicate that some of these are formed when the feed channel reaches a layer whose rigidity does not allow to progress, thereby causing the lateral spread of magma (Kavanagh et al., 2006). There are several publications studying emplacement models of these bodies in compressive environments (Galland et al., 2007; Montanari et al., 2010; Menand, 2011; Ferre et al., 2012; Walker et al., 2016) which reveal that the bodies are constructed from amalgamation of successive pulses of tabular bodies, that are emplaced through fault systems under compressive stresses.

The Malargüe FTB is a suitable place to study the mode of emplacement of neogene shallow intrusives likes sills, dykes and laccoliths. Figure 1 shows the distribution of the main bodies exposed in our study area.

In the NE area (Fig. 1) the Laguna Amarga body and other shallow intrusive rocks are emplaced over a wide area coincident with a backthrusts system affecting basement rocks located in the hanging wall of the Carrizalito thrust (Turienzo et al., 2012). This relationship was also observed in seismic lines and exploration wells where it is possible to observed sills intruded in Late Jurassic-Early Cretaceous rocks at the footwall of the thin-skinned Sosneado and Mesón thrusts. This implies that the feed channels of intrusive bodies must be deeper than those thrusts. Therefore we consider that the emplacement of the Laguna Amarga laccolithic body may be associated with the underneath backthrust system generated in the hangingwall of the thick-skinned Carrizalito thrust (Araujo et al. 2013, 2019).

To the south of the Atuel river (Fig. 1) the Cerro Chivato body seems to be emplaced benefitting from the weakness of the Auquilco Formation gypsum. In its eastern edge the body shows structural complexity in the contact with La Manga and Lotena Formations, disrupting and folding the strata. In the western side is possible to recognize the Tordillo Formation clearly resting on the intrusive in a concordant manner. We interpret that this intrusive could have been emplaced through a north-south thrust fault within the Auquilco gypsum. This fault can be observed within the strata located at the south edge of the intrusive, verging to the east.

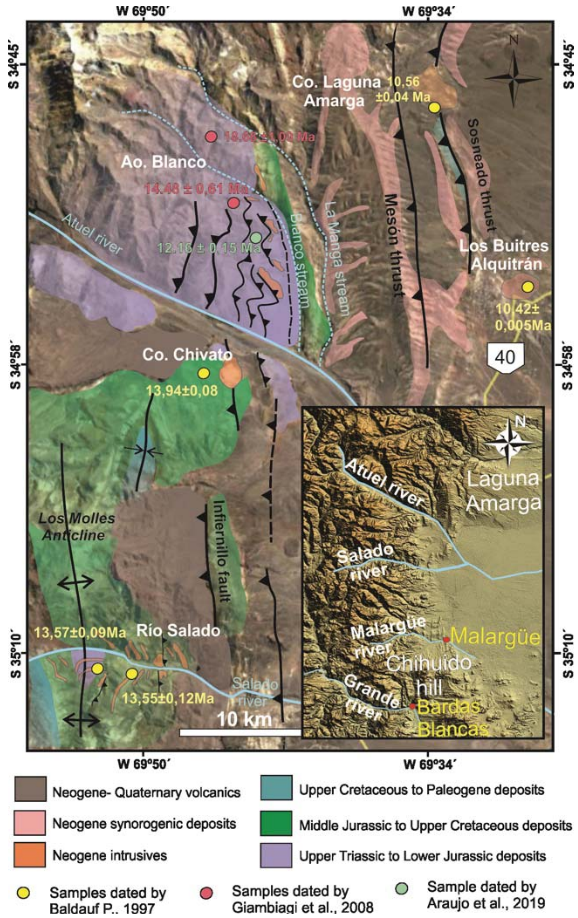

Figure 1: Satellite image with the distribution of the main bodies.

In the Chihuido area (Fig. 1), there are andesitic sills and dykes in contact with the Mendoza Group. In some sectors is possible to observe shales folded due to the intrusion of magma. On the floor of some of these sills there are ridge and groove structures parallel to the dip direction of the sedimentary layers. One of the intrusives has a thickness of about 15–20 cm and is located along the fault surface. The floor of this tabular body is concordant with the Mendoza Group sediments (footwall flat), and the roof is discordant with the same sediments (hangingwall ramp). This outcrop is evidence that the tabular body was emplaced through a thrust surface that was used as a feed channel (Fig. 2). On the other hand, in these areas there are some sills affected by faulting, indicating that some of them are pretectonic with the deformation produced by thrusts. Good evidence between the relation of emplacement and tectonics is founded in the Arroyo Blanco zone (Fig. 1), where the sills are intruded into the core of an anticline. There, an east dipping thrust (backthrust) duplicates the layers of the El Freno Formation. It is possible to interpret that this backthrust folded the sill. This igneous rock has an age $^{40}Ar/^{39}Ar$ on hornblende of 12.16 ± 0.15 Ma (Araujo et al. 2019). Therefore, this dating allows us to constrain the age of thrust deformation.

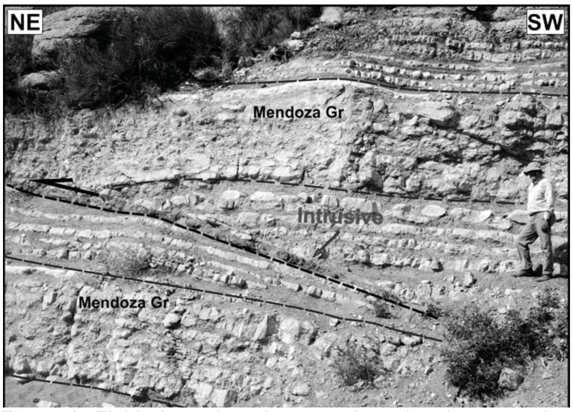

Figure 2: Field photo that shows an intrusive that uses the fault zone as a feed channel. Black dashed line indicates a thrust, blue dashed lines indicate top and bottom of strata on both hanging and footwall blocks.

Finally, the survey of the igneous bodies allowed us to define their morphology, thus helping to provide evidence on the mechanisms of emplacement in the upper crust and led us to establish the close relationship of these bodies with the Andean contractional fault systems.

It is interpreted that these thrusts have acted as feeding channels for the ascent of magma and therefore there is a direct link between the distribution of magmatism and fault systems. The igneous bodies are emplaced through low-angle faults and it results in longitudinal strips of intrusive bodies of younger ages towards the Andean foreland.

The expansion of the Andean magmatism may be based on the close relationship between the simultaneous progress towards the foreland of thrust systems and igneous bodies without necessity of considering significant displacement of the sources of magma

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