Summary

Granitic plutons often display distinct concentric zoning, identifiable through variations in textures, structures, mineral content and chemical varia-
tions from the center toward the edges of the plutons. Plutons can be normally zoned from more mafic margins to more felsic cores, or reverse zoned, where mafic zones are surrounded by felsic rims.

The Box Springs Plutonic Complex (BSPC) is a good example of a reverse zoned pluton. A ballooning emplacement model was proposed by Stock (1992). According to this model, the central tonalite expanded upward, displacing the wall rock, developing foliation, and assimilating crust at the edges of the pluton. This study proposes a detailed mapping and structural, geochemical, and geochronological analysis to understand the complex zoning and emplacement of the different units in the BSPC.

Geologic setting

The BSPC presents an elliptical shape and stands out for its diverse textures, compositional, and porphyritic zonation. It consists of five major units described from the core to mafic high-silica biotite tonalite to foliated tonalite and granodiorite in the edges (Morton et al., 2014). It is situated in the northeastern margin of the Peninsular Ranges Batholith (PRB). This zone has undergone deformation at 380 Ma. Most of the plutons in the area are charac-
terized by complex emplacement mode, well foliated fabrics, dated of emplacement of 4 to 6 kyr. Sv values of 7.894–8.7059, positive (Nd), and HfO 1.6.

Fig. 1. Initial strucutres, structures and textures of the Box Springs Plutonic Complex in the southern part of the Peninsular Ranges Batholith and the suggested units. Yellow: Tonalite and granodiorite; green: biotite tonalite; bloush: monzogranite; light brown: pegmatitic granite; white: orthogneiss; orange: hornblende; black: schist. The topographic map was adapted from Morton et al. (2019), where the unit was used to determine the size of the source region (Fig. 2).

Mapping techniques

Field relationships and petrography

Units range from biotite tonalites, granodiorites, and granites at the center to layered porphyritic granodiorite and tonalites at the margins. The BSPC displays concentric zoning fabrics, including biotite-feldspar, and hornfels, which plunged towards the center. Fabrics intensity was found to be higher at the margin transitioning to the center. The contacts between units were mostly gradational, with evidence of magma mingling, enclaves, cognate inclusions, solution, and compositional layering.

Geochronology

Fig. 4. Kriging of the most characteristic major and trace elements with the location of the samples made by ArcGIS Pro with geostatistical wizard. A) SiO2 kriging. B) MgO kriging. C) CaO kriging. D) Na2O kriging. E) P2O5 kriging. F) K2O kriging. G) Fe2O3 kriging. H) ZnO kriging. I) Zr kriging.

Fig. 5. Model of evolution for a steep-walled magma chamber with buoyant fractionated liquids (McBirney and Baker, 1981). In which crystallization from the walls and roof produces more buoyant fractionated liquids (McBirney and Baker, 1981).

Fig. 6. Mean age spectra of the most characteristic major and trace elements and geochronological parameters for the BSPC. A) MSWD = 1.1, p(x²) = 0.38 B) MSWD = 2.9, p(x²) = 2.8e-06 C) MSWD = 2.2, p(x²) = 0.79 | 0.79Ma D) MSWD = 2.2, p(x²) = 0.00385 E) MSWD = 2.2, p(x²) = 0.00385 F) MSWD = 2.2, p(x²) = 0.00385 G) MSWD = 2.2, p(x²) = 0.00385 H) MSWD = 2.2, p(x²) = 0.00385 I) MSWD = 2.2, p(x²) = 0.00385

The mechanism proposed for the BSPC is most like one proposed by Bourne and Davis (1987). This model suggests:

- Emplacement of a large magma reservoir; onset of crystallization and move-
net of liquid toward the roof.

- Plagioclase at the center can be monomineralic to form an “upper reser-
voir” or “lower reservoir.”

- Lenses, magma from the deeper source, form to diapirs that intruded the cen-
tral part of the upper reservoir having less contact with crustal components.

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