Magma mingling and mafic enclaves: structural relations within upper crustal plutons in the Peninsular Ranges batholith Mesa Grande 7.5' Quadrangle, northern San Diego County, California

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ABSTRACT: The California Geological Survey currently is mapping the Mesa Grande 7.5' quadrangle in northern San Diego County as part of an ongoing effort with the USGS to produce seamless geologic maps of 7.5' and 30' x 60' quadrangles in California. New mapping revealed spectacular exposures of agmatite, a field term for commingled fine-grained gabbroic dikes and felsic host rocks (Paterson et al., 2010; Dave Tucker, 2010).

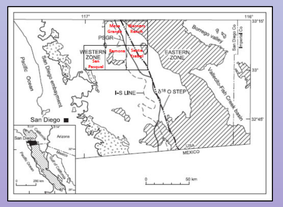
In Carney Canyon, agmatite consists of felsic granitic rocks that contain sub-equal volumes of fine-grained gabbroic rocks, mostly as ribbon-like inclusions (mafic enclaves). The agmatite body measures about 5 km long and 1.5 km wide, and strikes NNE, approximately parallel to the strike of steeply dipping foliation and contacts in this area. It is bounded on the east by a pluton of Alpine tonalite and a lensoid body of gabbro. The western contact is with a pluton of Japatul Valley tonalite, mapped along the west side of Pamo Valley, a NNE-oriented fault-controlled valley that exhibits evidence of brittle and ductile deformation extending northward to the Elsinore Fault Zone.

The Alpine tonalite pluton and one or more gabbro plutons, including Black Mountain to the east, are cut by leucogranite dikes emplaced sub-parallel to the plutonic contacts. These dikes may emanate from the same source as numerous, small- to- medium-size leucogranite plutons that are spatially associated with the gabbro plutons east of Carney Canyon.

Possible parental magmas for the agmatite in Carney Canyon are the Alpine tonalite and the Cuyamaca Gabbro. If Alpine tonalite was the granitic parent, it may have undergone some degree of crystal fractionation to more silicic compositions. Alternatively, if the granitic parent was derived from the same magma source that produced the leucogranite dikes and plutons, the agmatite may have intruded a fault zone between tonalitic and gabbroic magmas.

Smaller, but similar, bodies of agmatite in San Diego County have been attributed to mingling of approximately coeval granitic and gabbroic magmas (e.g., Todd and Hernandez, 2014).

The area is within the western zone of plutons in the Peninsular Ranges batholith that crystallized at pressures between 3 and 4 kb. Detailed mapping will improve our understanding of structures and emplacement histories of upper crustal plutons in the western zone of the PRB.




agmatite


agmatite


agmatite

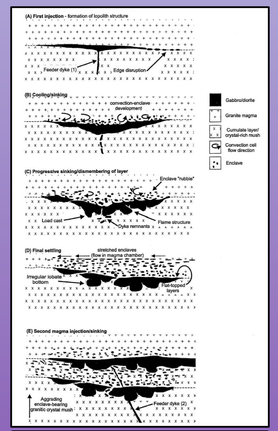


Figure 2: Model of mafic layering in granitic magma, referred as MAFIC AND SILICIC LAYERED INTRUSIONS (MASLI).
Figure modified from Wiebe, R.A., and Collins, W.J., 1998 *in* Collins et al. (1998)

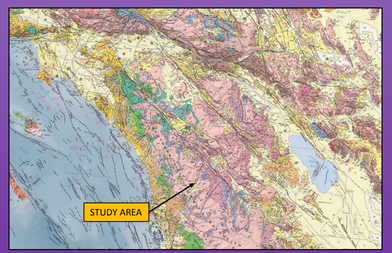


Figure 1: Mesa Grande 7.5' quadrangle - within the Peninsular Ranges batholith
Source: California Geological Survey, Digital Geologic Map of California.
http://maps.conservation.ca.gov/cgs/gmc/

Pluton	Plutonic Suite (batholithic zone)	Lithology	Characteristic features	Age* (Ma) (U-Pb zircon) *Shaw et al, 2014 where noted
Cuamaca Gabbro (Kc)	Cuyamaca Gabbro (western and eastern zones)	Pyroxene gabbro and diorite; hornblende gabbro and diorite	Very fine-grained to medium-grained, heterogeneous	Undated; agpaitic coeval with Klp
Japatul Valley (Kjv)	Japatul Valley (western zone)	Biotite-hornblende tonalite; in many rocks, biotite and hornblende subequal; borderline tonalite-granodiorite and lesser granodiorite	Variably abundant mafic inclusions for which fabric is subparallel to mineral foliation; local seriate texture (hornblende)	100.9 ± 0.7*
Corte Madera (Kcm)	Corte Madera (western zone)	Leucocratic biotite granodiorite, monzogranite, and syenogranite; locally with minor hornblende	Coarse-grained, abundant quartz, white-weathering; greatest relief plutons	Undated; ages of closest Kcm plutons: ca. 115 and 114*
Alpine (Ka)	Alpine (western zone)	Orthopyroxene-subequal hornblende and biotite tonalite and quartz diorite; marginal rocks, quenched quartz diorite and diorite	Variable mafic inclusions; mafic-mineral aggregates up to 5 cm	Ca. 107*
Leucocratic dikes (Kl)	Corte Madera and La Posta (?)	Pegmatite, aplite, alaskite, and leucogranite dikes in all plutons.		98.7 ± 0.3 ($^{206}Pb/^{207}Pb$)*
Las Bancas (Klb)	Las Bancas (western and eastern zones)	Pyroxene-hornblende-biotite tonalite; lesser biotite-pyroxene and biotite-hornblende-pyroxene quartz gabbro	Medium-grain size, biotite oikocrysts as large as 2.5 cm	101.0 ± 1.1* 101.6 ± 0.4*
Granite Mountain (Kgm)	Granite Mountain (western and eastern zones)	Pyroxene hornblende biotite tonalite, granodiorite, quartz diorite	Sparse to common mafic enclaves in tonalite; scarce rhythmically layered (felsic, mafic layers) cumulate rafts	101 ± 2 (U.L. Kimbrough, oral commun., 1994); Todd et al, 2003
Cuyamaca Reservoir (cyr)	Cuyamaca Reservoir (eastern	Hypersthene-biotite granodiorite and subequal tonalite	steep-walled, elongate plutons, fine-grained mafic enclaves and metasedimentary inclusions	Late and Middle Jurassic
Julian Schist (JTrm)	Julian Schist Metasedimentary and metavolcanic rocks (eastern)	upper amphibolite facies metasedimentary rocks with amphibolite	semi-pelitic, and quartzitic schists, calc-silicate metaquartzite, and minor amphibolite	Jurassic and Triassic
Harper Creek(JHc)	Harper Creek Gneiss (eastern)	gneissic to mylonitic biotite granodiorite and subequal tonalite	fine- to medium-grained, abundant inclusions of metasedimentary rocks and amphibolite	Late and Middle Jurassic

Figure 3: Description of selected map units, Mesa Grande 7.5' quadrangle. Mapping in progress, V. Todd and J. Hernandez, 2016

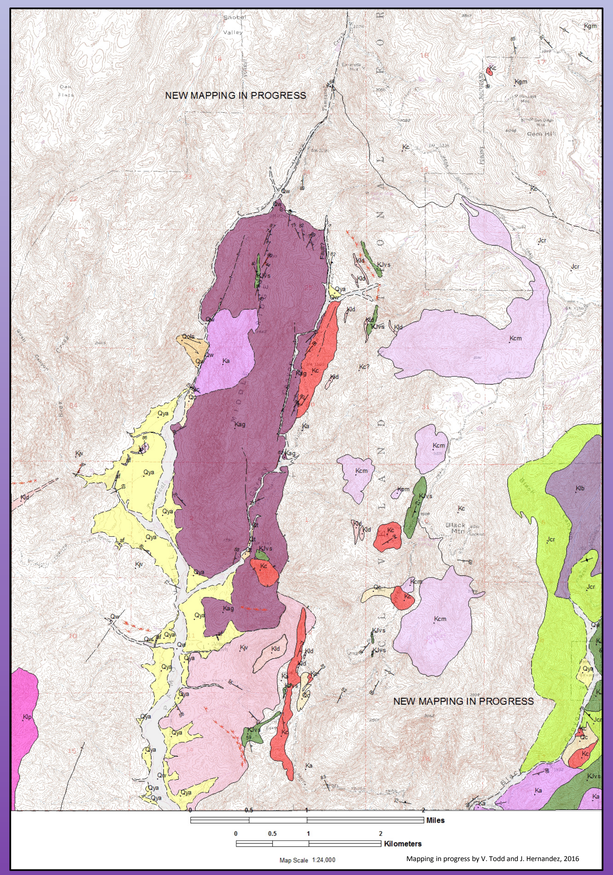


Figure 4: Mesa Grande 7.5' quadrangle, southwestern portion of the map area.


agmatite


agmatite


agmatite


Kc – Cuyamaca gabbro


agmatite


agmatite


Kjvs


Kjvs


Kjvs


Ka- Alpine tonalite


Kjvs

Selected References

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