New constraints on the origin of rhyolitic magmatism within the Salton Trough: evidence for episodic remobilization of hydrothermally altered intrusives

AXEL K. SCHMITT¹, JORGE VAZQUEZ², and JEFFREY HULEN³

1 DEPARTMENT OF EARTH AND SPACE SCIENCES, UNIVERSITY OF CALIFORNIA, LOS ANGELES; 2 DEPARTMENT OF GEOLOGICAL SCIENCES, CALIFORNIA STATE UNIVERSITY, NORTH RIDGE; 3 ENERGY AND GEOSCIENCE INSTITUTE, UNIVERSITY OF UTAH, SALT LAKE CITY

1 Introduction

The Salton Sea Geothermal Field (Imperial Valley, CA) is regarded as a prime candidate for future geothermal development, with the potential of quintupling its presently installed capacity of ~300 MW.

In the course of recent geothermal well drilling, evidence has emerged for thick (several 100 m) subsurface rhyolites intercalated with Pleistocene basin sediments. Located at depths between ~1,500 and 2,800 m, these youthful rhyolites are highly altered and were encountered at borehole temperatures of 200 - 300°C.

Following up on this discovery, we reassessed the magmatic history of the Salton Sea Geothermal field by geochronologic and petrologic study of zircon from surface and subsurface rhyolites.

2 Geological Background

The Salton Trough is the northernmost extension of incipient continental rifting along the Gulf of California (Fig. 1). Rifting and subsidence accelerated at ~4 Ma, generating pull-apart basins that were filled by Colorado river-derived clastic sediments. Near-surface geothermal gradients are elevated by up to a factor of 10, and recent magmatic activity is evident by surface outcrops of five rhyolitic domes (Salton Buttes, Fig. 2). These rhyolites contain cm to dm sized inclusions of metasedimentary, basaltic, and granite compositions.

Subsurface diabase and andic rocks have been previously described from several geothermal wells, the latter being commonly regarded as intrusive equivalents of the Salton Buttes. Newly discovered rhyolites have a pyroclastic carapace and consist of aphyric devitrified glass. Deeper intersections have been texturally identified as intrusive.

3 Age of surface rhyolites and granitic inclusions

Zircons from two dome rhyolites (Fig. 3) (Escondido Butte, Red Island) overlap in their Th-U isotopic compositions (Fig. 3 A). The data are fitted by two isochrons. The older isochron age (19.2 ka ± 6) is within error of the granite zircon age, while the younger age is 12.9 ka (n = 11).

Two zircons that plot on the equiline were identified by subsequent U-Pb analysis as xenocrysts. Zircon in two granitic inclusions from Escondido Butte are present as interstitial anhedral grains with patchy cathodoluminescence (CL) patterns and spongy textures (backscatter electrons BSE; Fig. 4). 206Pb/238U zircon analysis indicates significant disequilibrium and yields a regression age of 20.1 ka (Fig. 3 B).

5 Zircon oxygen isotopic and REE compositions

Zircons from surface and subsurface rhyolites display relatively low δ18O values, e.g., compared to detrital contaminants (Fig. 7). Zircons from granitic inclusions have even lower values, characteristic for involvement of isotopically light oxygen derived from meteoric waters. REE patterns for granitic zircons are light REE enriched, characteristic for hydrothermal zircon (Fig. 8).

6 Summary and implications

Surface rhyolitic zircon ages overlap with published obsidian hydration rim ages that yielded ages between 2.5 and 8.4 ka. This suggests minor pre-eruptive residence, but older zircon overlaps in age with granitic inclusion zircons imply that ~10 ka older precursor intrusions were involved in the magmatism of Salton Buttes rhyolites. Oxygen isotopic composition of zircon reveals a low δ18O signature, interpreted as the result of remelting of hydrothermally altered basaltic intrusions.

By analogy to the surface rhyolites, the U-Pb zircon ages for subsurface rhyolites are interpreted to be close (within few ka) to the eruption age. These results therefore provide the first radiometric age constraint for sedimentation rates in the center of the Salton Trough, with ~4 mm/a twice the amount previously estimated.