Cenozoic Volcanism of Patagonia, South America

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Study Area

Estancia Glencross Area (EGA) Volcanics

- ~200km East of Andean Cordillera
- Buttes are volcanic necks with rare relict lava flows
- Intervening areas are reworked by glacial action

Detailed Study Area

EGA Petrography

- Age dates range from 8.5-8.0Ma
- Subalkaline basalts to basaltic andesites
- Porphyritic texture
  - Phenocrysts: Olivine and Clinopyroxenes
  - Groundmass: Plagioclase

EGA Volcanics

D'Orazio et al. (2001)

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Intervening areas are reworked by glacial action
EGA Geochemistry

- Primitive chemical signature
- High in Mg, Fe, Ni, Cr, V, and also SiO₂
- Very low in Al
- Sr ratios range from 0.7032-0.7034
- Consistent with an intraplate or OIB, but less than 200km east of Andean Cordillera

Hypotheses

- Need to introduce pristine asthenosphere beneath crust
  - Slab-driven convection and upwelling
  - Formation of a “SlabWindow”

Slab Window Hypothesis

Once ridge is subducted, upwelling material no longer cools to build the plates and they become “unzipped”

Upwelling mantle-derived magma either pools beneath crust or intrudes into it.

Thorkelson (1996)

Slab Window beneath EGA

SAP: South American Plate
AP: Antarctic Plate
NP: Nazca Plate
CT: Chilean Trench
NPMA: Nazca Plate Magmatic Arc

Support for Hypothesis

- Relative motion vectors put slab window beneath EGA at 10 Ma, 1-2 Ma before eruption
- No intermediate to deep earthquakes are present at this latitude

Detailed Study Area

D’Orazio et al. (2001)
Pali Aike Volcanic Field (PAVF)

- ~90km East of EGA Volcanic Field
- Three stages of volcanism
  - Plateau-forming tabular lava flows >100m thick
  - Old deeply eroded volcanic centers
  - Newer nearly pristine volcanic centers

Pali Aike Volcanic Field (PAVF)

D’Orazio et al. (2000)

PAVF Petrography

- Ages range from 3.78-0.17 Ma (oldest in the west)
- Mostly alkaline basalts
- Often include ultramafic garnet and/or spinel-bearing xenoliths

PAVF Geochemistry

- Primitive chemical signature
- High in Mg, Ni, Cr, Ti
- Sr ratios of 0.70317-0.70339
- Again, typical of intraplate or OIB

Timing of Eruption

- Slab window should have been under PAVF at ~9Ma, but eruption does not begin until ~4Ma
- Unlike EGA with only 1-2 My lag
- Why did magma not intrude upper crust for almost 5 My?

Patagonian Orocline

Cunningham (1993)
**Summary**

- SAP: South American Plate
- AP: Antarctic Plate
- NP: Nazca Plate
- CT: Chilean Trench
- NPMA: Nazca Plate Magmatic Arc
- APAV: Antarctic Plate Arc Volcanism

**North American Analogs**

Andesitic arc volcanics from Guatemala to Nicaragua

OIB signatures similar to EGA and PAVF in Costa Rica and Panama

Also observed in California, where East Coast Range volcanics display typical arc signatures while inboard Southern California Basin volcanics are more primitive

**Conclusions**

- Although EGA and PAVF volcanic fields are very close to the Andean Cordillera, they are quite different compositionally.
- This difference is probably due to primitive mantle upwelling through a “slab window.”
- The EGA volcanics intruded the upper crust 1–2 My after the passage of the window, while the PAVF lagged ~6 My.
- This lag was probably due to stress changes in the Patagonian Orocline.
- Evidence for slab windows can be found along other destructive boundaries.

**Questions**

**References**