Late Miocene Volcanism of NW Mexico

and the Trans-Mexican Volcanic belt

“The great debate”

Geology 581

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Summary

1. Intro to NW Mexico 35-13 Ma
2. Northwestern Mexico
   a. Tectonics
   b. Volcanics
   c. Rift or subduction??
   d. Answer
3. Intro to Trans-Mexican
4. Trans-Mexican Volcanic Belt
   a. Tectonics and Volcanics
   b. Petrology
   c. Subduction, plume, or window??
5. Debata!
6. Relation of NW Mexico to Trans-Mexican VB
7. Conclusion
8. Relation to USA and food for thought!

Introduction to NW Mexico

Andean style 35 Ma
- Farallon plate Subduction and orthogonal rifting of the Gulf of California
- Farallon plate broke into fragments and subduction ceased locally 24 Ma
- Volcanism occurred intermittently along the east side of Baja and on the immediate west coast of Mexico
  - Ended 16 Ma in north
  - Ended 11 Ma in south

Neogene tectonic evolution of the Gulf of California

I) Farallon plate subduction along entire margin
   - Younger crust subducted
   - Magmatic arc in the Sierra Madre Occidental shifted west starting at 28 Ma
   - New arc in Gulf area 24 Ma
II) Farallon plate breakups (Guadalupe microplate)
   - Followed continued path or was transferred to Pacific plate
   - Transition from subduction to extension
III) Baja underwent orthogonal extension 12-6 Ma
IV) Rifting with dextral component of motion
   - New oceanic crust in Gulf
   - Baja fully transferred to Pacific plate

Volcanism

24-15 Ma
- Most volcanic rx's emplaced
  - 55-65% SiO2
  - More felsic Sierra Santa Ursula up to 70% SiO2
14-11 Ma
- 65-78% SiO2 - predominately calc-alkaline
- Porphyritic texture (plagioclase phenocrysts)
- More felsic flow contain alkali feldspars and plagioclase with altered mafics
- Trachyandesites emplaced throughout
10-8 Ma
- 51-54% SiO2 - basalts and andesites
- Isla Tiburon - rhyolite tuffs
- Continental flood basalts

Rift or Subduction?

Subduction of Guadalupe plate corresponds to volcanism in the Sierra Santa Ursula (15 Ma)
- Change from intermediate to felsic (>15 Ma)
  - Increasing resistance of younger subducting Guadalupe plate
- Tholeiitic magmatism - early history of orthogonal extension (10.3-8.5 Ma)
- Trace elements of Miocene rx's in Sierra Santa Ursula show fractional crystallization
  - Mantle source heterogeneous
  - Different magma source
  - Different degrees of partial melting
**Introduction to Trans-Mexican Volcanic Belt**

- Turning on the Trans-Mexican Volcanic Belt took place mid-late Miocene.
- During the formation of the Gulf there was an emplacement of mafic lavas.
- Debate over origin of basalts!!

**Tectonics**

- Late Miocene mafic lavas near major fault zones
  - Concurrent with transtensional or extensional reactivation of faults
  - Tepic Plateau lavas placed immediately to west of NW Pochtitan fault system
  - Mafic dikes parallel
  - Ceboruco and San Cristobal mafic successions located along north edge of Jalisco block
  - Los Altos de Jalisco mafic lavas cover boundary of Sierra Madre and Michoacan block

**Tectonics and volcanics**

- Regionally tectonic transition from subduction to rifting
  - Noted by the progression of:
    1) Calc-alkaline (24-15 Ma)
    2) Felsic calc-alkaline (15-11 Ma)
    3) Tholeiitic Basalt (10-8 Ma)

**Tectonics and volcanics**

- Petrology
  1) Plateau like formations
    - A) Tepic plateau
      - Basalts-basaltic andesites
      - Olivine + clinopyroxene phenocrysts
      - Ground mass (plag, clino, oxides and olivine)
      - Calc-alkaline trend
    - B) Punta Mita
      - Basalts-basaltic andesites
      - Euhedral olivine phenocrysts
      - Ground mass (plag, clino, olivine, oxides and olivine)
      - Less alkali rich than Tepic

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2) Petrology

- **San Cristobal Basalt (11.2-8.5 Ma)**
  - Basalt – andesite
  - Phenocrysts of plag. and euhedral olivine
  - Groundmass same as phenocryst
  - Seriate texture (continuous range of xstals)

- **Los Altos de Jalisco Lava (10.2-8.7 Ma)**
  - Basalt – andesite
  - Some benmorites and mugearites
  - Phenocrysts of plag. and euhedral olivine
  - Groundmass of plag., olivine, and Fe-Ti oxides

3) Petrology

- **Queretero Volcanics (9-8 Ma)**
  - Mafic to intermediate volcanic rxs
  - Phenocrysts of plag. and minor olivine
  - Groundmass same as phenocryst
  - (microcrystalline to cryptocrystalline)
  - Porphyritic to seriate texture

- **Pathe Lavas (8-7 Ma)**
  - Subakaline (basaltic-andesite comp.)
  - Phenocrysts of plag. And microphenocrysts of rounded olivine
  - Groundmass cryptocrystalline
  - Porphyritic texture

**What is going on?**

- Westward decrease in orogenic signature
  - Suggest more complex subduction rather than mantle plume
- Slab free window?
  - Cessation of subduction north of 20° (12.5 Ma)
  - Diverging subduction of Rivera and Cocos (9.9-7.9 Ma)
  - “could” place western TMVB above slab free area

**What “could” happen over slab free window?**

- Sub-slab asthenosphere melts upwell around northern and eastern margin of descending Rivera Plate
  - Subduction altered mantle wedge interacts with the aforementioned
- Transitional magmas from Tepic to San Cristobal are result
- Transtensional reactivation of zone of weakness facilitated magma ascent
  - Asymmetric distribution
  - Basalts > Intermediate and silicic rxs
Relations to USA

- **Western Mexico Vs USA**
  - Right lateral displacement of California and Baja (Unzipping of soon to be exotic terrane)
  - Waves of volcanism before rifting (mechanism of Laramide Orogeny all along the West coast of NA)

- **Trans-Mexican Volcanic Belt**
  - Flood basalts are 3-orders of magnitude smaller than the Snake River Plains Flood Basalt
  - Snake River caused by hot-spot
  - TMVB
    - Early hot spot? (no)
    - Unique subduction

References

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