Late Miocene Volcanism of NW Mexico and the Trans-Mexican Volcanic belt

"*The great debate*"

Geology 581

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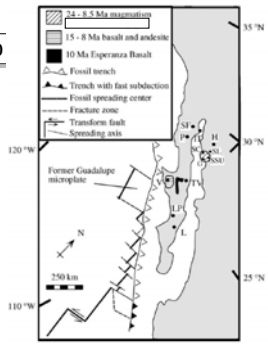
Summary

- Intro to NW Mexico 35-13 Ma
- Northwestern Mexico
  - Tectonics
  - Volcanics
  - Rift or subduction??
  - Answer
- Intro to Trans-Mexican
- Trans-Mexican Volcanic Belt
  - Tectonics and Volcanics
  - petrology
  - Subduction, plume, or window??
  - Debate!
- Relation of NW Mexico to Trans-Mexican VB
- Conclusion
- 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



NW Mexico 13 Ma

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 rxs 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

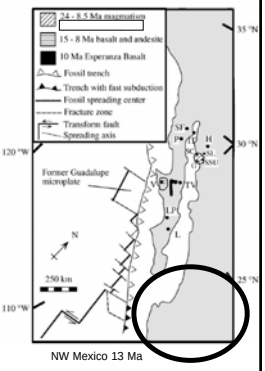
Rift or Subduction?

- 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 rxs in Sierra Santa Ursula show fractional crystalization
  - Mantle source heterogeneous
    - Different magma source
    - Different degrees of partial melting

Answer

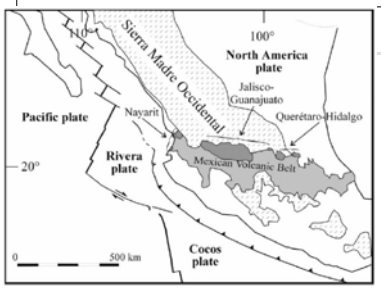
- ***Regionally tectonic transition from subduction to rifting***
  - Noted by the progression of:
    - 1) Calc-alkaline (24-15 Ma)
    - 2) Felsic calc-alkaline (15-11 Ma)
    - 3) Tholeiitic Basalt (10-8 Ma)

Southward ho!



NW Mexico 13 Ma

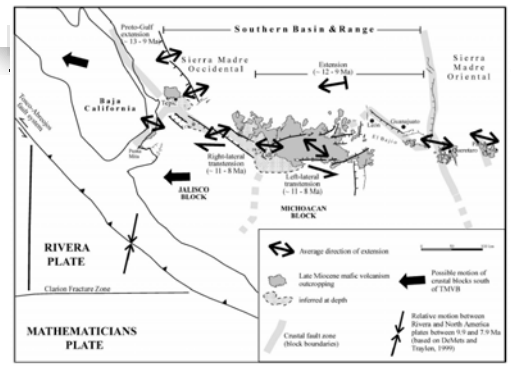
Introduction to Trans-Mexican



The four major plates in reference to the Trans-Mexican Volcanic Belt and the three subdivisions of volcanic terrains. Dark grey are exposed lavas.

- 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!!

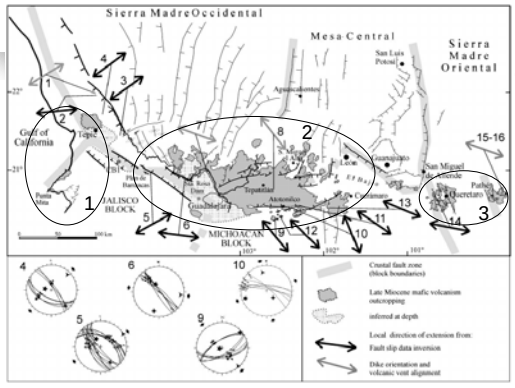
Tectonics and volcanics



Tectonics

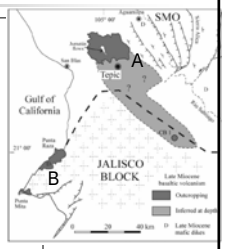
- Late Miocene mafic lavas near major fault zones
  - Concurrent with transtensional or extensional reactivation of faults
- Tepic Plateau lavas placed immediately to west of NW Pochtitan fault system
  - Mafic dikes parallel
- Ceboruco and San Cristobal mafic successions located along north edge of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

Tectonics and volcanics

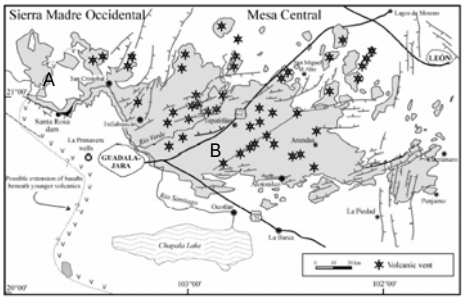


1) Petrology

- 8.9 Ma platue like formations
  - *A) Tepic platue*
    - Basalts-basaltic andesits
    - Olivine +clinopyroxene phenocrysts
    - Ground mass (plag, clino, oxides and olivine)
    - Calc-alkaline trend
  - *B) Punta Mita*
    - Basalts-balsaltic andesites
    - Euhedral olivine phenocrysts
    - Ground mass (plag, clino, olivine, oxides and olivine)
    - Less alkali rich than Tepic



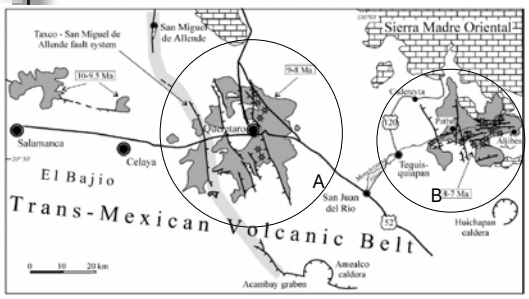
2) Petrology



2) Petrology

- A) San Cristobal Basalt (11.2-8.5 Ma)
  - Basalt – andesite
  - Phenocrysts of plag. and euhedreal olivine
  - Groundmass same as phenocryst
  - Seriate texture (continuous range of xstals)
- B) Los Altos de Jalisco Lava (10.2-8.7 Ma)
  - Basalt – andesite
    - Some benmorites and mugearites
  - Phenocrysts of plag. and euhedreal olivine
  - Groundmass of plag., olivine, and Fe-Ti oxides

3) Petrology



3) Petrology

- A) 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
- B) 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 20º (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

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- Ferrari, Luca, Conticelli, Sandro, Vaggelli, Gloria, Petrone, Chiara M., and Manetti, Piero, Late Miocene volcanism and intra-arc tectonics during the early development of the Trans-Mexican Volcanic Belt, Tectonophysics, V. 318, pg., 161-185, 2000.
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