Post-Grenvillian tectonomagmatic evolution of the southwestern Laurentian front

Munazzam Ali Mahar, Anthony Alvarez, Jason Ricketts, Philip Goodell

University of Texas at El Paso
Methods

Zircon U-Pb dating of West Texas granites and associated Basalt dikes.

Zircon Hf isotopes composition

Whole-rock geochemistry

Integrating geochronological and geochemical data with spatially and temporally related magmatic rocks.
Orientation of Laurentia with respect to western and southern continents at ~1.1 Ga

- Dalziel et al., 2000
- Li et al., 2008
- Evan, 2009
- Mertanen and Pesonen, 2012
- Merdit et al., 2017
- Mulder et al., 2018
Southwestern and South eastern Laurentia and Grenvillian orogeny (1.3-1.1Ga)
Lithotectonic units and Pre Neoproterozoic Geology of Southwestern Laurentia

Mulder et al., 2017
1.1 Ga magmatism in southwestern Laurentia and Franklin Mountain
Geochemistry Red Bluff granite and mafic dikes

Diabase dikes
Geochemistry of Red Bluff granite and mafic dikes
Zircon U-Pb geochronology of granites and diabase dikes

Oldest individual dates in granites = 1176-1138 Ma
No inheritance from Paleo-Mesoproterozoic crust.
Zircon U-Pb Geochronology of granites and diabase dikes

Oldest individual dates in diabase dikes ========= 1260-1155 Ma
No inheritance from Paleo-Mesoproterozoic crust.
Zircon Hf isotopic evolution of West Texas and other 1.1 magmatic rocks in southwestern Laurentia

Grenvillean magmatic rocks are more radiogenic than the Mesoproterozoic crust at 1.1 Ga
Formation of Continent-Arc type Southwestern Laurentia

Modified after Li et al., 2008

Mulder et al., 2018
Collision of Laurentia with a southern continent at ~ 1200-1150 Ma

Remnant of accreted arc assemblages
Tectonomagmatic model for alkaline magmatism, deformation, leucogranites and migmatization in the west Texas and Llano 1.1 Ga

Oldest dates in granites and diabase dikes represent the timing of basaltic underplating i.e., 1175-1150 Ma

About 30-40 Ma later, slab breakoff and orogenic collapse at 1100 Ma resulting remelting of recently underplated basalt (amphibolites) and emplacement of granites
Is Grenvillean orogeny an older analogue to the Himalayan collision zone

Not a new idea though

Or oblique collision at the indenting corner?

Head to head collision?
South Eastern Grenville comparison to India-Asia head to head collision

Collision of Amazonia and Southeast Laurentia

Head to head India-Asia collision

Ca, 1450 Ma

SE Amazonia

Laurentia NW

Accretion of Montauban arc

Montauban terrane

Ca, 1370 Ma

Opening of Elzevir back-arc basin

Remnant arc

Ca, 1250–1220 Ma

Closure of Elzevir marginal basin, initiation of SE-directed subduction

Ca, 1220–1180 Ma

Accretion of Elzevir and Frontenac terranes (remnants of back-arc basins)

Ca, 1180–1120 Ma

Widespread crustal- and mantle-derived magmatism on Laurentian margin, limited extension

Ca, 1090–980 Grenvillian Orogeny: formation of ABT at ca. 1090 Ma, ABT reworked in extension at ca. 1020 Ma, formation of GF at ca. 1000 Ma

Ca, 140 Ma

India

Lhasa terrane

Qiangtang terrane

Eurasia

Ca, 100 Ma

Lhasa terrane

BNS

Gangdese batholith

Ca, 55 Ma

Collision between India and Eurasia, UHP metamorphism

Ca, 23 Ma – Present

Formation of MCT and STD and generation of leucogranite ca. 23 Ma

Formation of MBT ongoing
India-Asia collision at northwestern indenting corner

alkaline granites, syenites and lamprophyre (30-13 Ma)
Post orogenic slab break off and magmatism ~30 Ma following continent-continent collision

Northwestern Himalaya

- Southern most Laurentia is similar to the southern margin of Asian plate in northwestern Himalaya.
- Break off of descending slab under both plates.
- Deformation, uplifting, and HT metamorphism
- A sandwiched arc in both zones
- Alkaline magmatism ~30 Ma following continent-continent collision

Southwestern Laurentia

1.1 Ga granites

Partially melting of basaltic underplate and SCLM

Asthenosphere upwellings
Conclusion

- Granites and associated basaltic dikes yielded overlapping ages (~1.1 Ga) and Hf isotopes composition.

- Mafic dikes are possibly related to the basaltic underplate resulted by partial melting of SCLM which remelted by decompressing asthenosphere during a slab breakoff event.

- Absence of zircon inheritance and Hf isotope composition suggest minimal input from older Mesoproterozoic crust, perhaps southern margin of Laurentia is dominantly underlain by juvenile crust.

- For the origin of granites partial melting of basaltic under plate (amphibolites) is suggested.

- Southwestern Laurentia is similar to the southern margin of Asian plate in northwestern Himalaya both have recorded alkaline magmatism, migmatization, deformation and uplifting ~30 Ma following continent-continent collision.