SHALE PROVENANCE OF THE MESOPROTEROZOIC UNKAR GROUP, GRAND CANYON, ARIZONA:

GRENVILLIAN INFLUENCE ON SEDIMENTATION OF INBOARD RODINIA

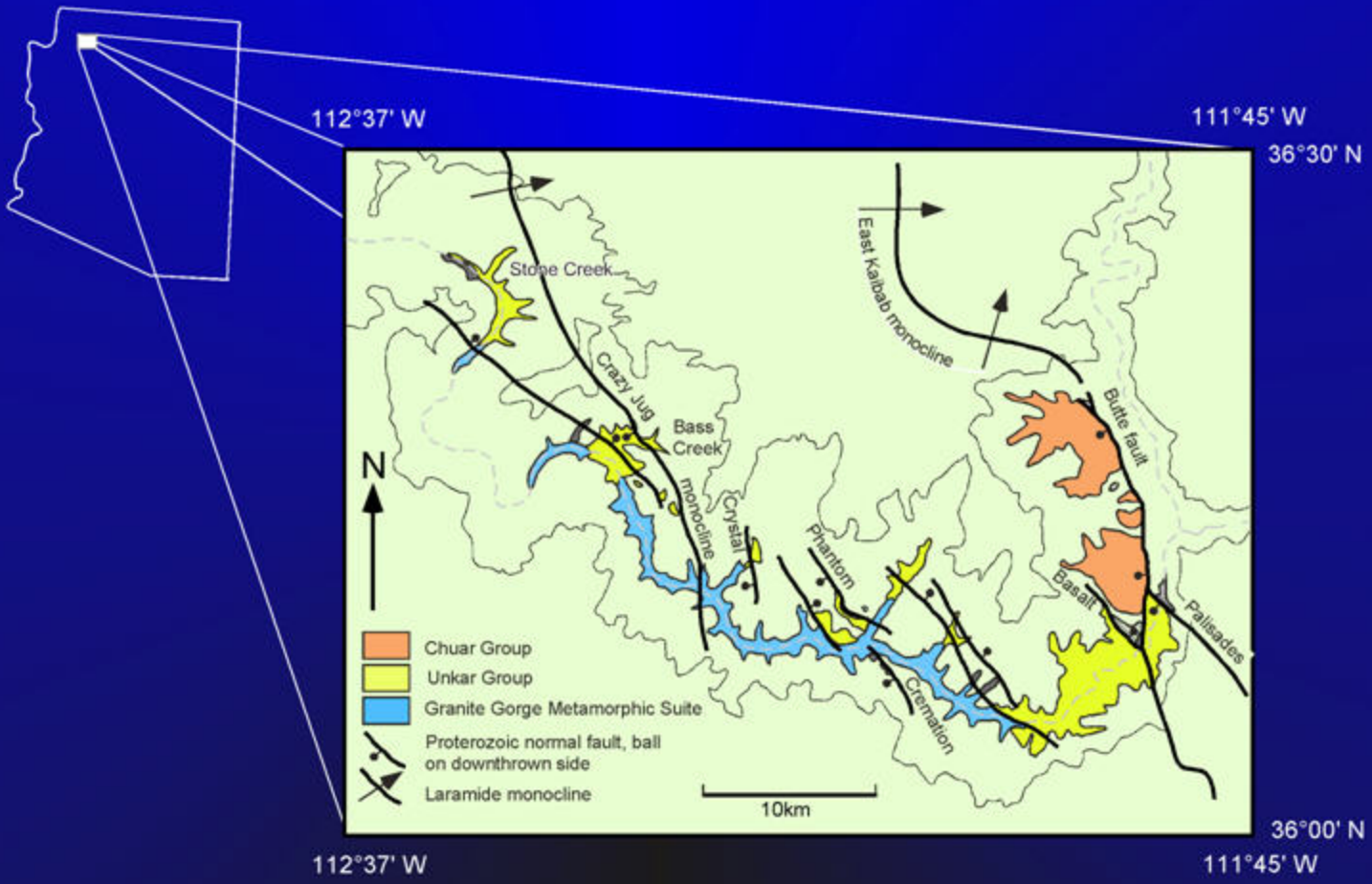
J.D. Bloch, L.J. Crossey, K.E. Karlstrom – University of New Mexico
J. M. Timmons – New Mexico Bureau of Geology & Mineral Resources
G.E. Gehrels – University of Arizona

Funding by NSF

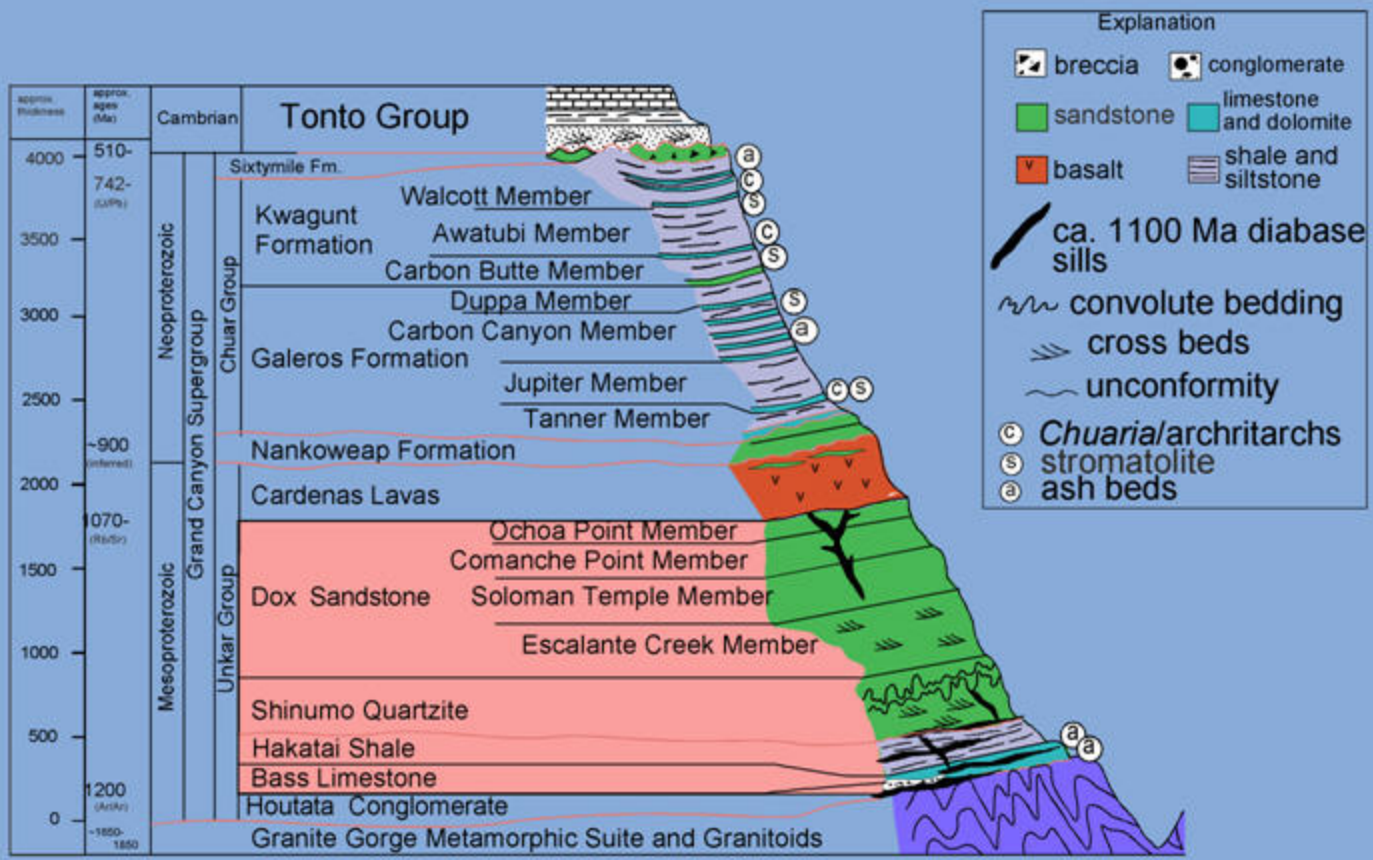
1. Where does the Unkar Group sediment come from?

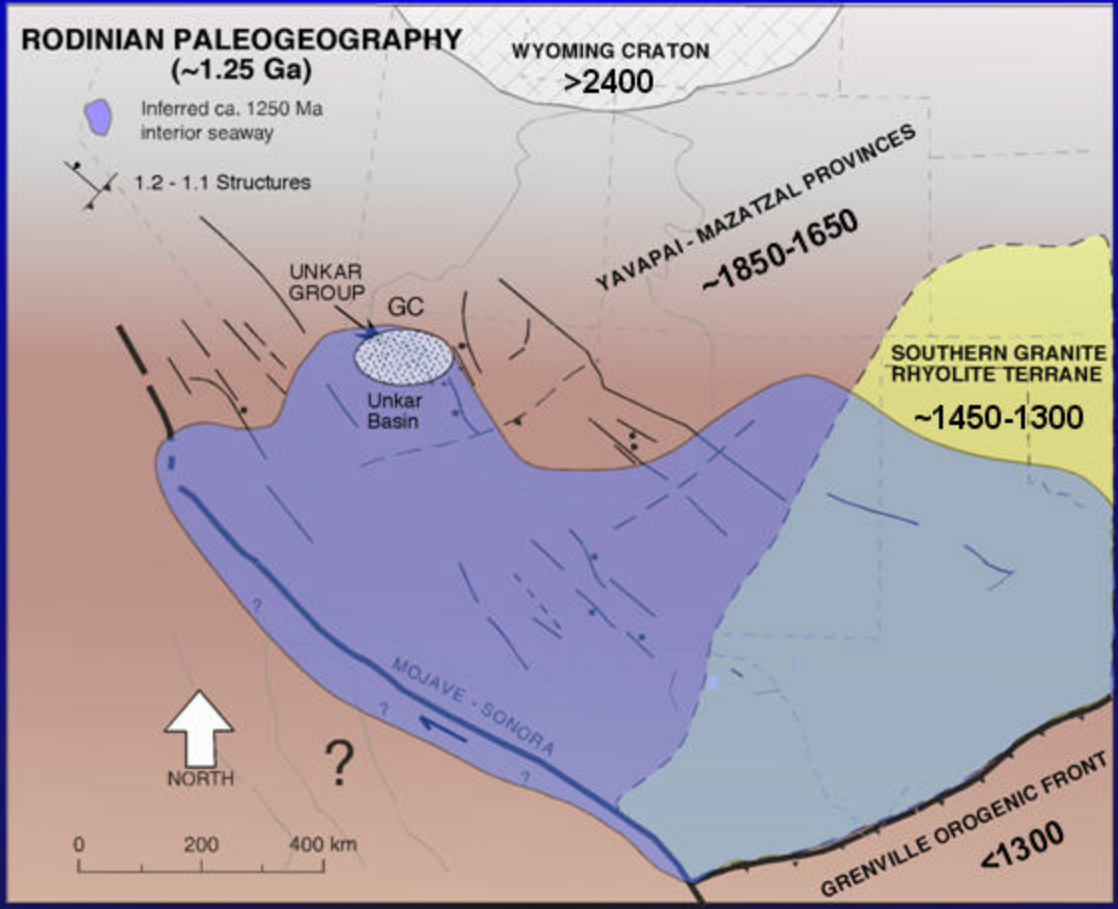
2. How variable is the composition?

3. Can we discern the effects of weathering, transport and diagenesis to obtain meaningful provenance information?

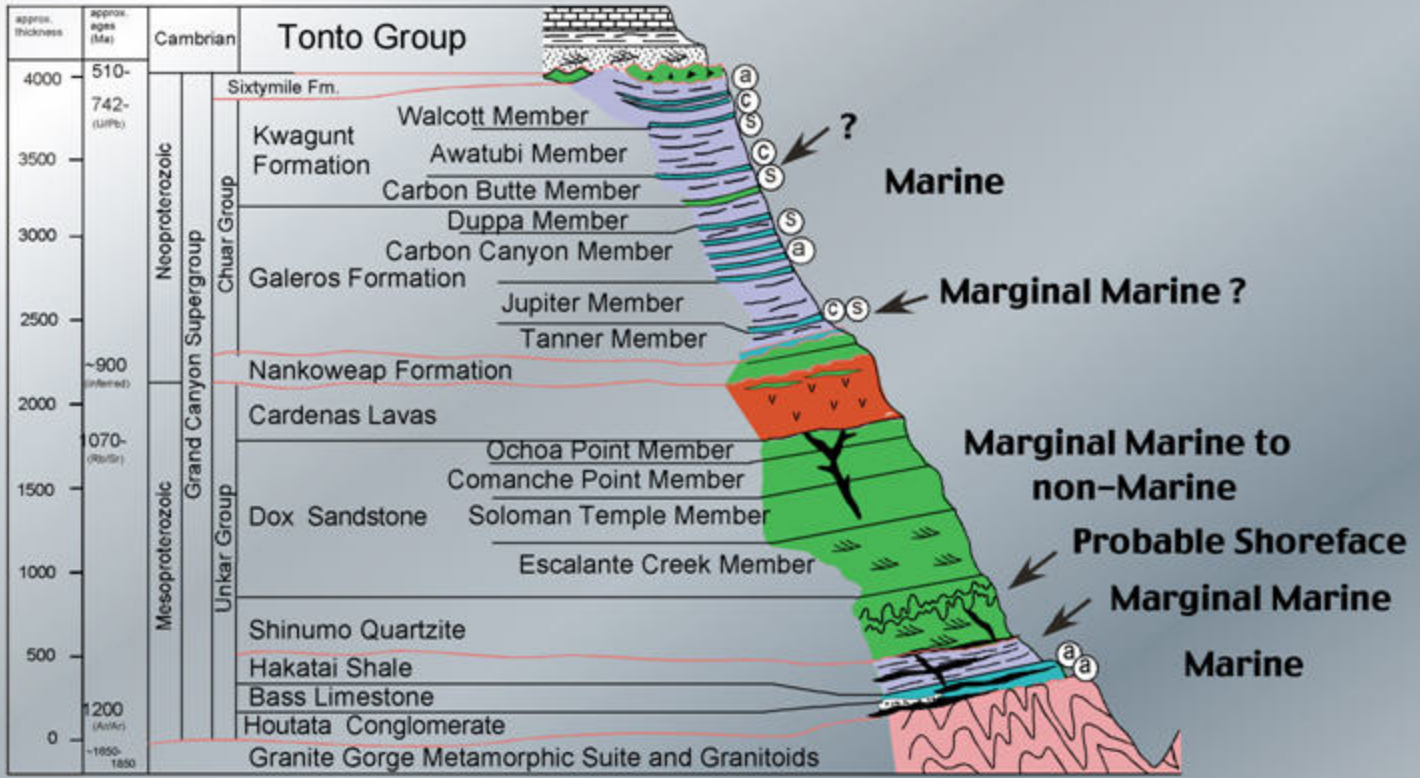


Timmons (2004)


approx. thickness
approx. ages (Ma)
4000
3500
3000
2500
2000
1500
1000
500
0
510-
742-
(U/Pb)
~900
(inferred)
1070-
(Rb/Sr)
1200
(Ar/Ar)
~1650-1850
Cambrian
Neoproterozoic
Mesoproterozoic
Grand Canyon Supergroup
Chuar Group
Unkar Group
Tonto Group
Sixtymile Fm.
Kwagunt Formation
Walcott Member
Awatubi Member
Carbon Butte Member
Duppa Member
Carbon Canyon Member
Galeros Formation
Jupiter Member
Tanner Member
Nankoweap Formation
Cardenas Lavas
Dox Sandstone
Ochoa Point Member
Comanche Point Member
Soloman Temple Member
Escalante Creek Member
Shinumo Quartzite
Hakatai Shale
Bass Limestone
Houtata Conglomerate
Granite Gorge Metamorphic Suite and Granitoids
Explanation
breccia
conglomerate
sandstone
limestone and dolomite
basalt
shale and siltstone
ca. 1100 Ma diabase sills
convolute bedding
cross beds
unconformity
Chuaria/archritarchs
stromatolite
ash beds



Timmons et al. 2004


Depositional Environments
approx. thickness
approx. ages (Ma)
4000
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(U/Pb)
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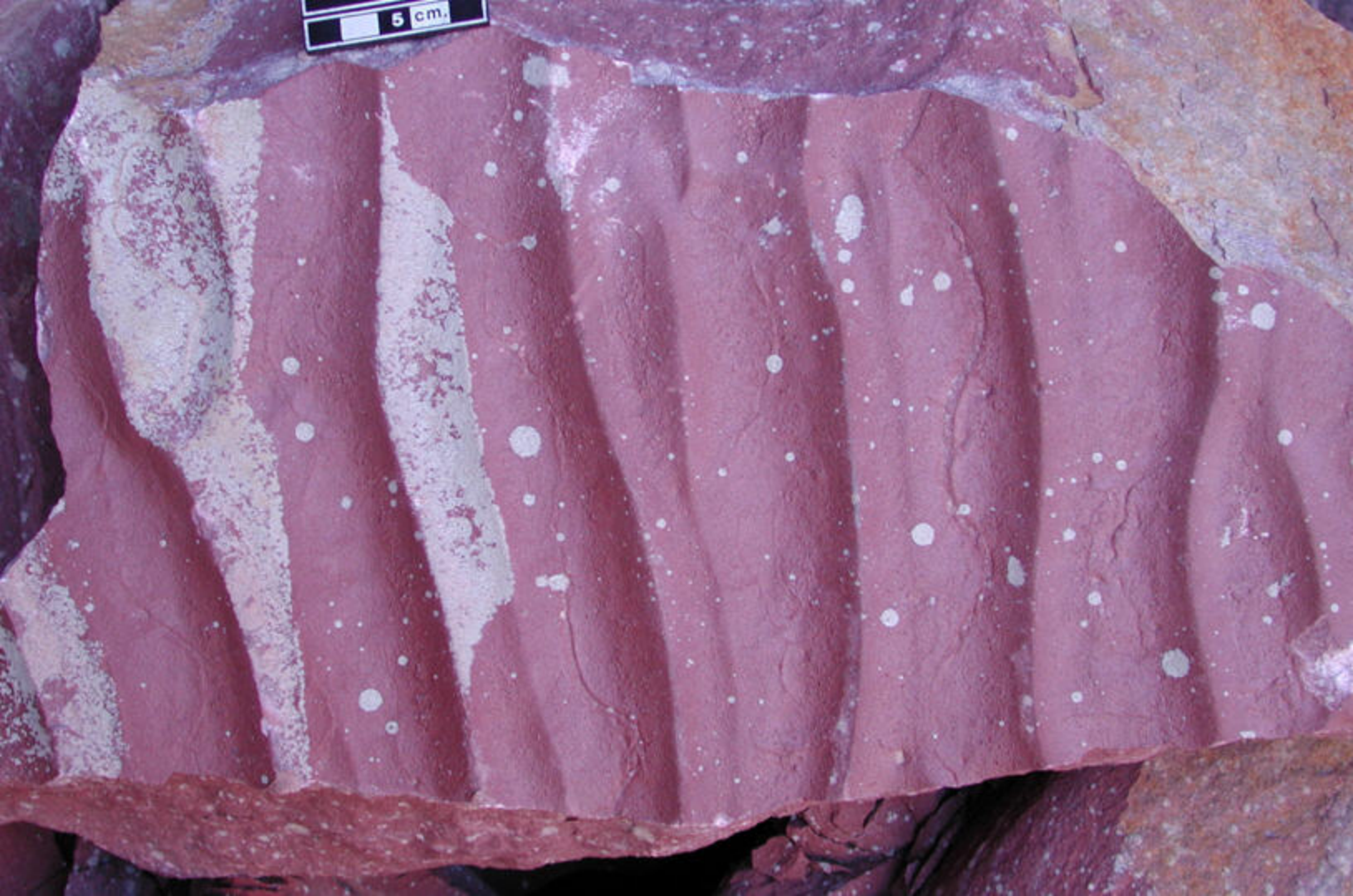
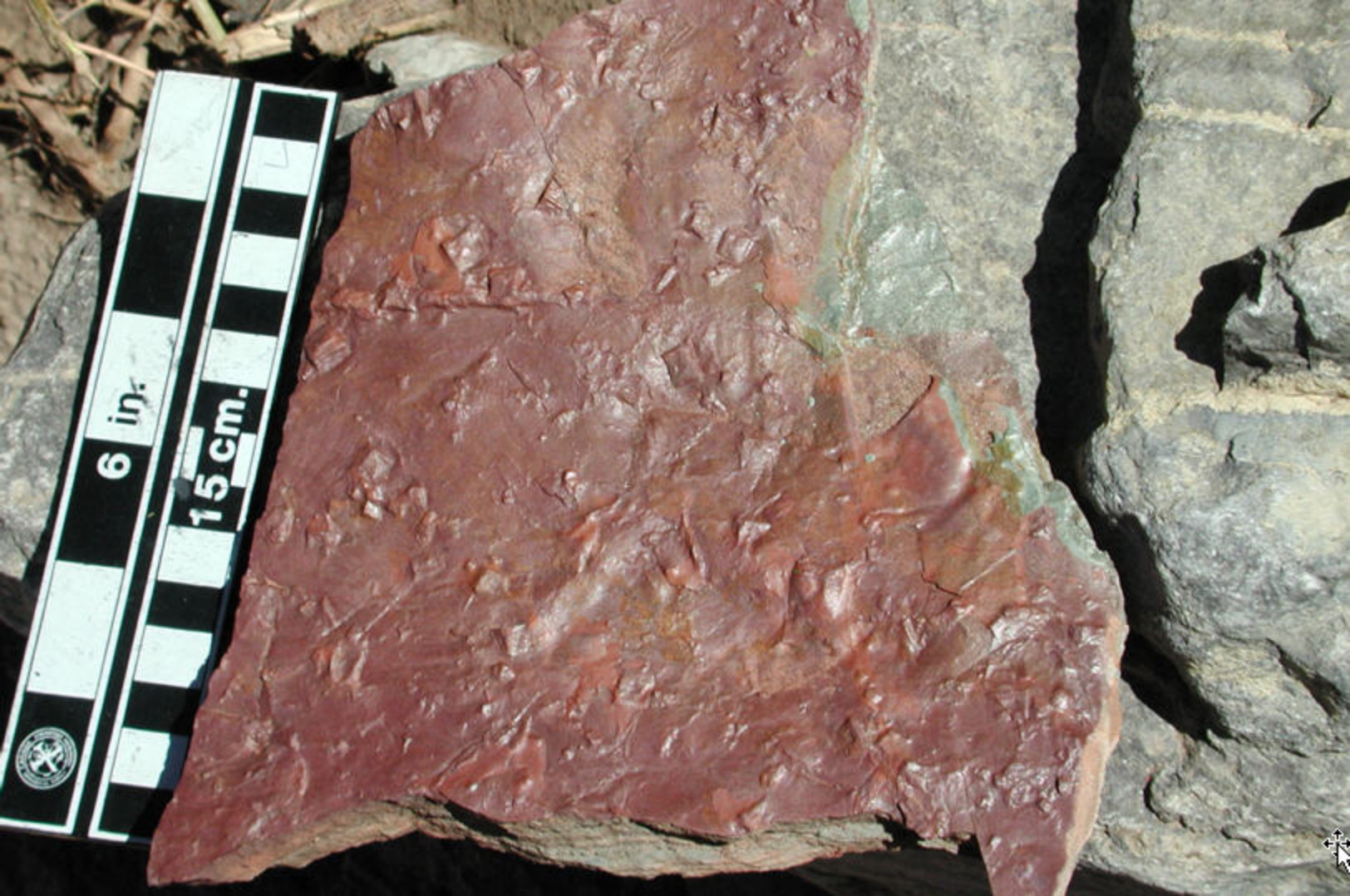
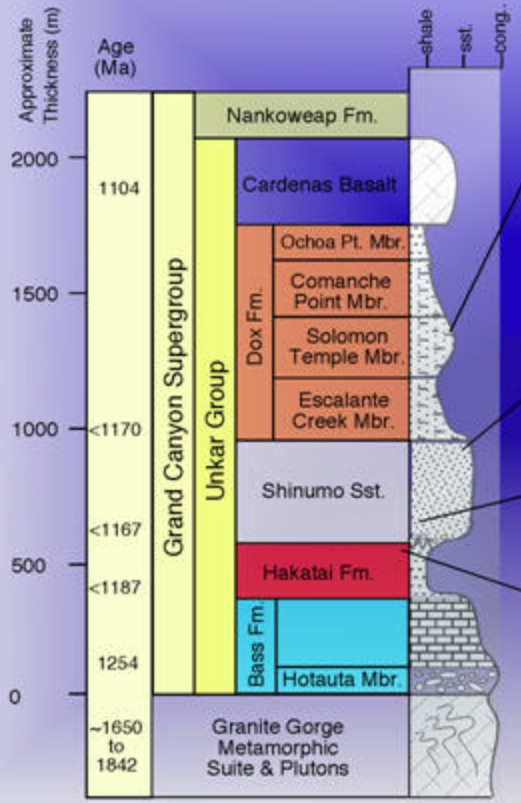
Escalante Creek Member
Shinumo Quartzite
Hakatai Shale
Bass Limestone
Houtata Conglomerate
Granite Gorge Metamorphic Suite and Granitoids
?
Marine
Marginal Marine ?
Marginal Marine to non-Marine
Probable Shoreface
Marginal Marine
Marine

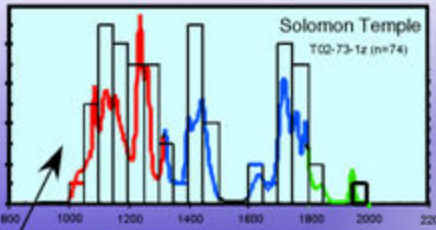

5 cm.

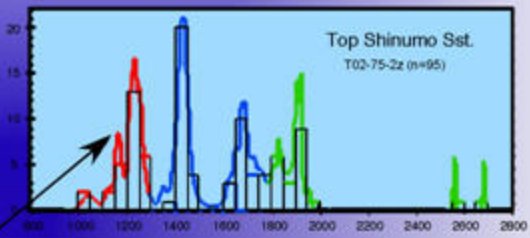

6 in.
15 cm.

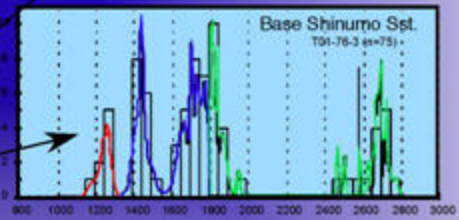

6 in.
15 cm.

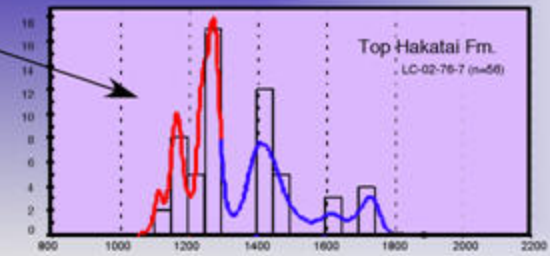
sst zircon age distributions

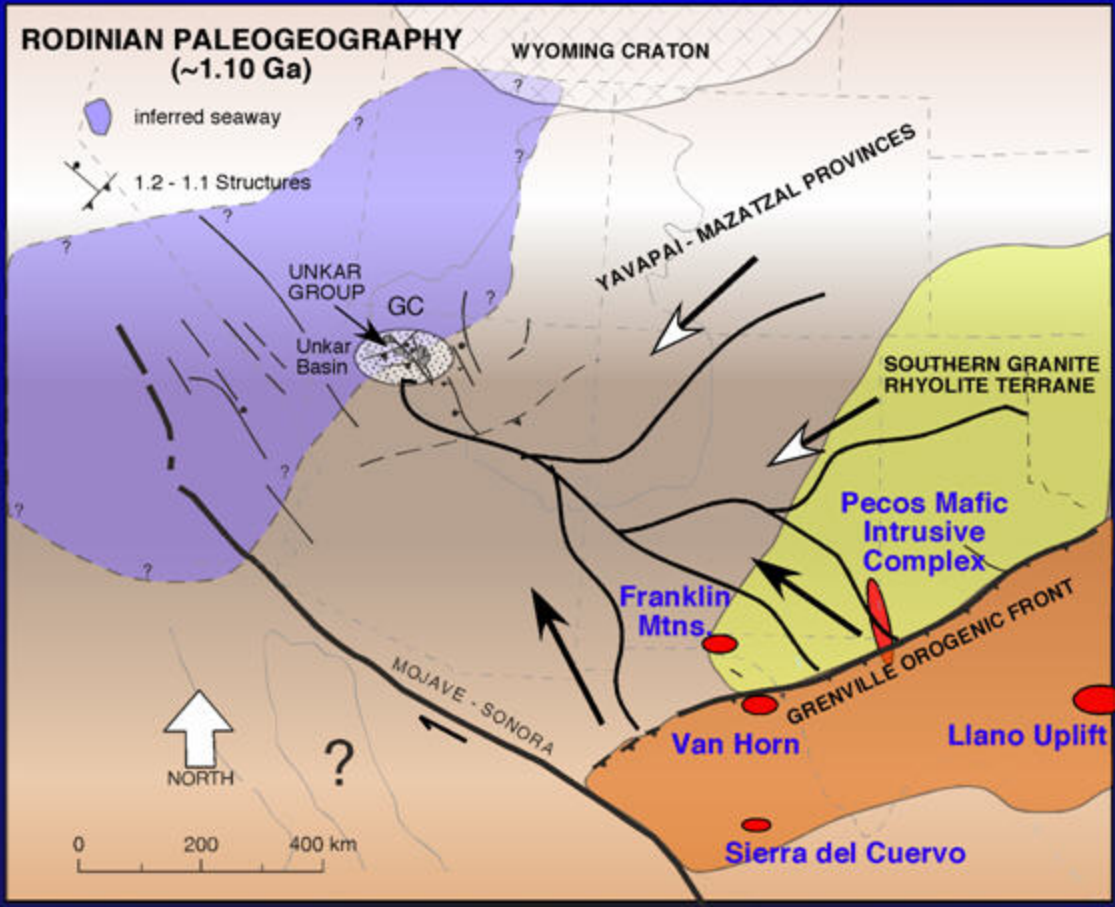




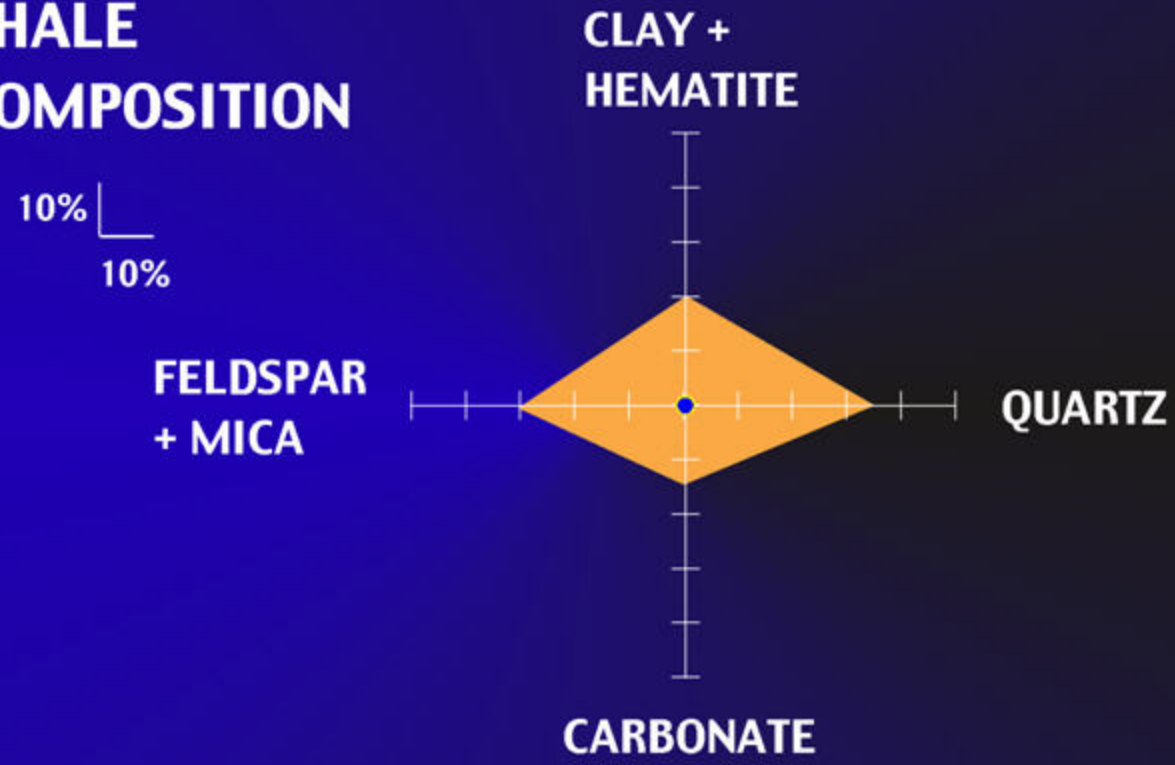







RODINIAN PALEOGEOGRAPHY
(~1.10 Ga)
WYOMING CRATON
inferred seaway
1.2 - 1.1 Structures
YAVAPAI - MAZATZAL PROVINCES
UNKAR GROUP
GC
Unkar Basin
SOUTHERN GRANITE RHYOLITE TERRANE
Pecos Mafic Intrusive Complex
Franklin Mtns.
GRENVILLE OROGENIC FRONT
MOJAVE - SONORA
Van Horn
Llano Uplift
Sierra del Cuervo
NORTH
?
0
200
400 km

SHALE COMPOSITION

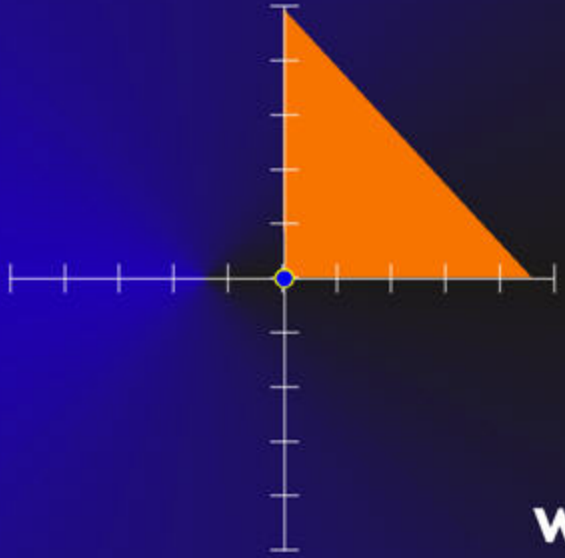


(after Shaw & Weaver, 1965)

SHALE COMPOSITION

10%

10%



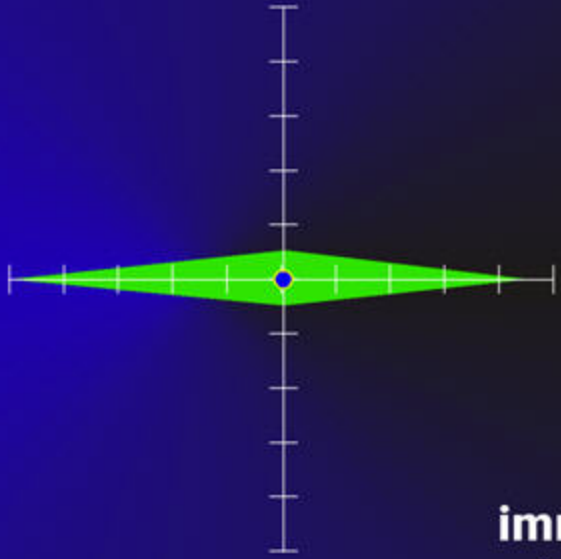
weathered
or winnowed

SHALE COMPOSITION

10%

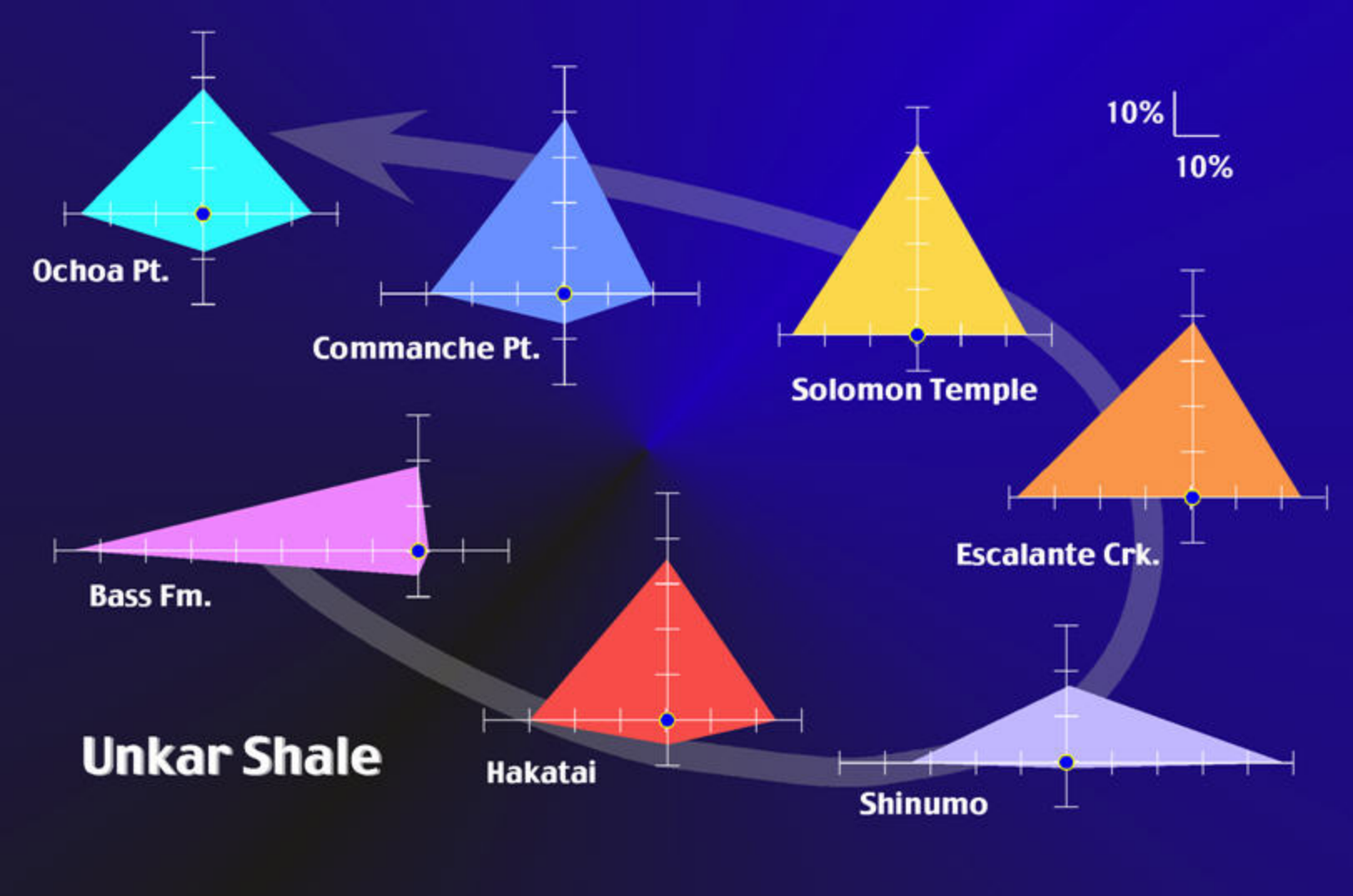
10%

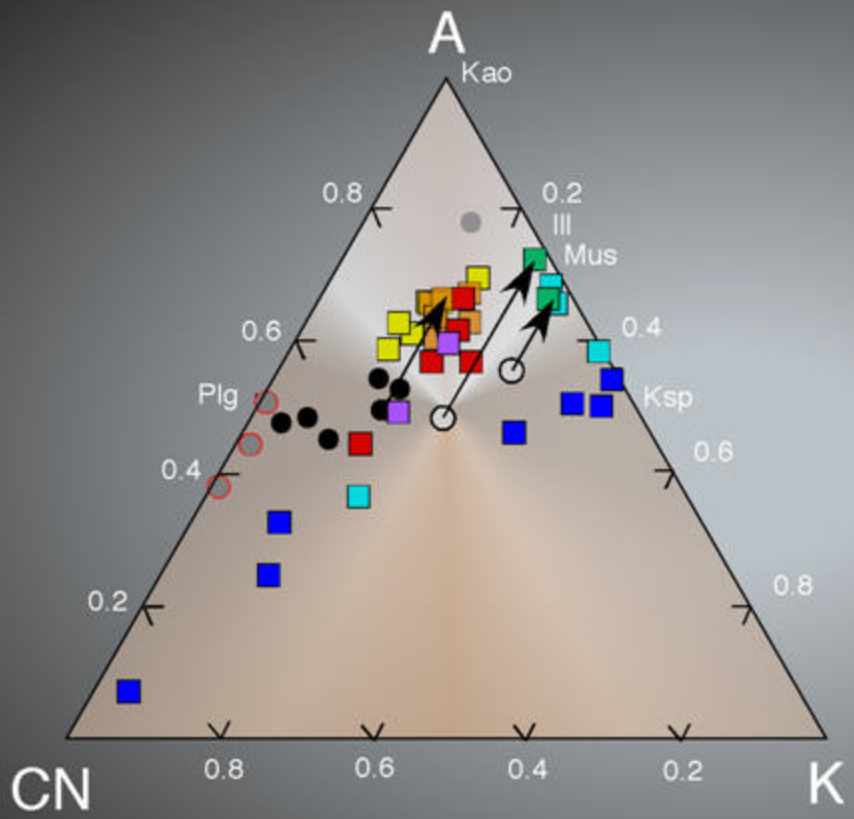
FELDSPAR + MICA



QUARTZ

immature, winnowed, or prograde diagenesis

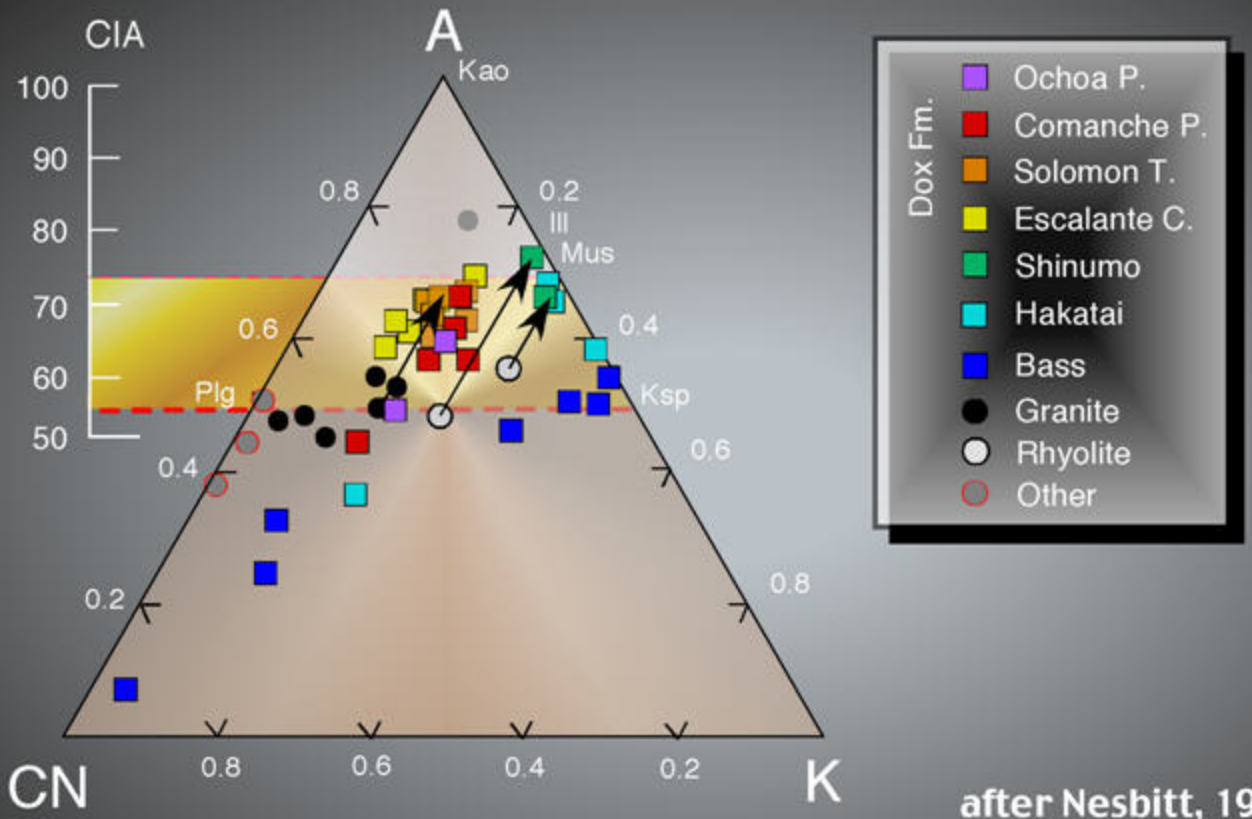

10%
10%
Ochoa Pt.
Commanche Pt.
Solomon Temple
Escalante Crk.
Bass Fm.
Hakatai
Shinumo
Unkar Shale



Dox Fm.

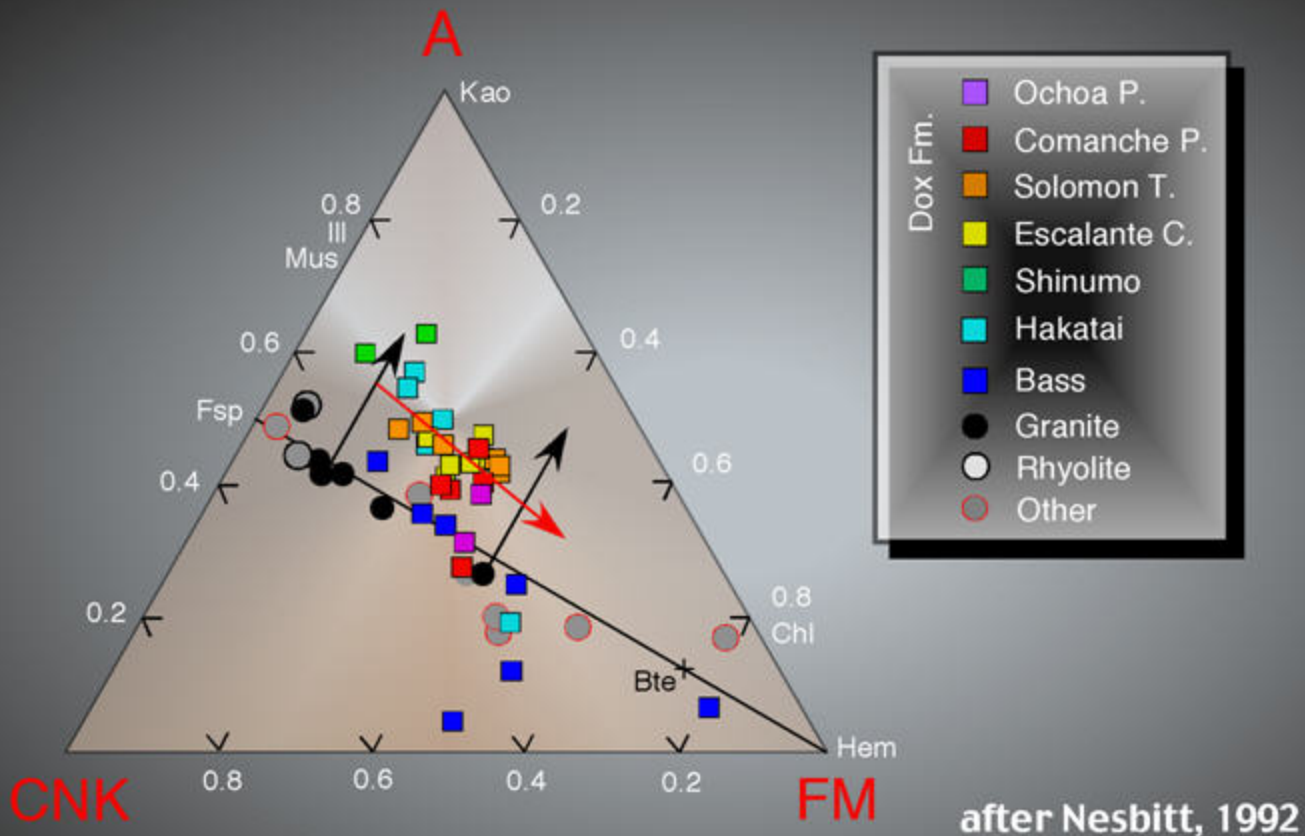
- Ochoa P.
- Comanche P.
- Solomon T.
- Escalante C.
- Shinumo
- Hakatai
- Bass
- Granite
- Rhyolite
- Other

after Nesbitt, 1992

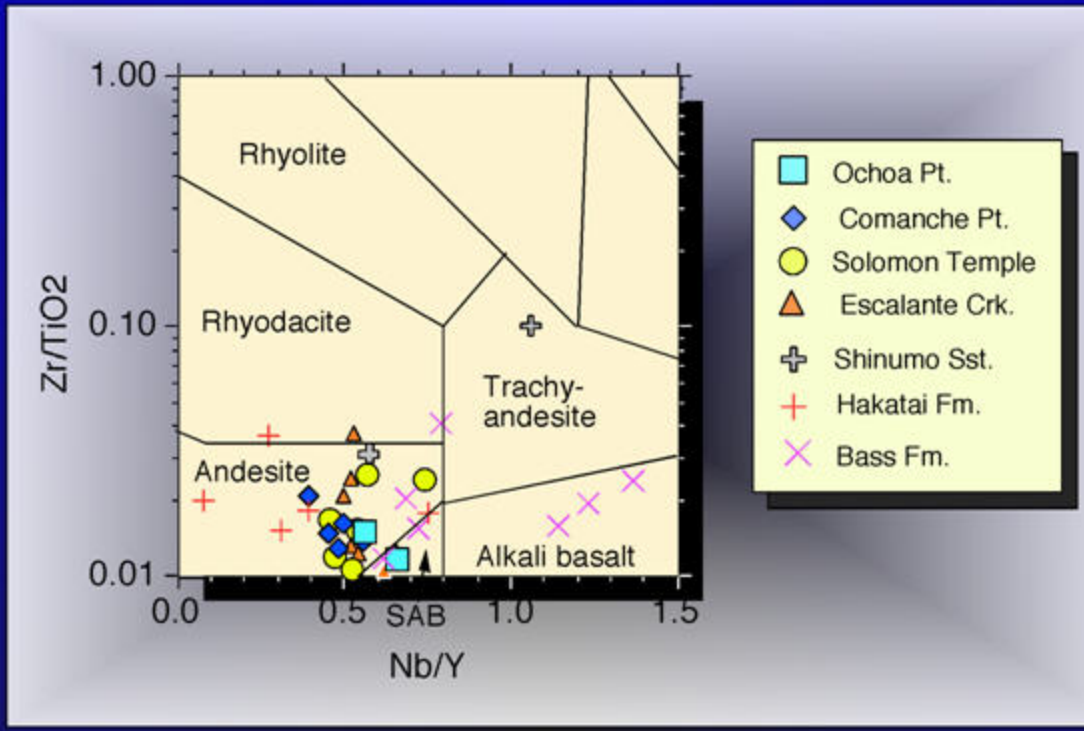


after Nesbitt, 1992

and Fedo et al., 1995



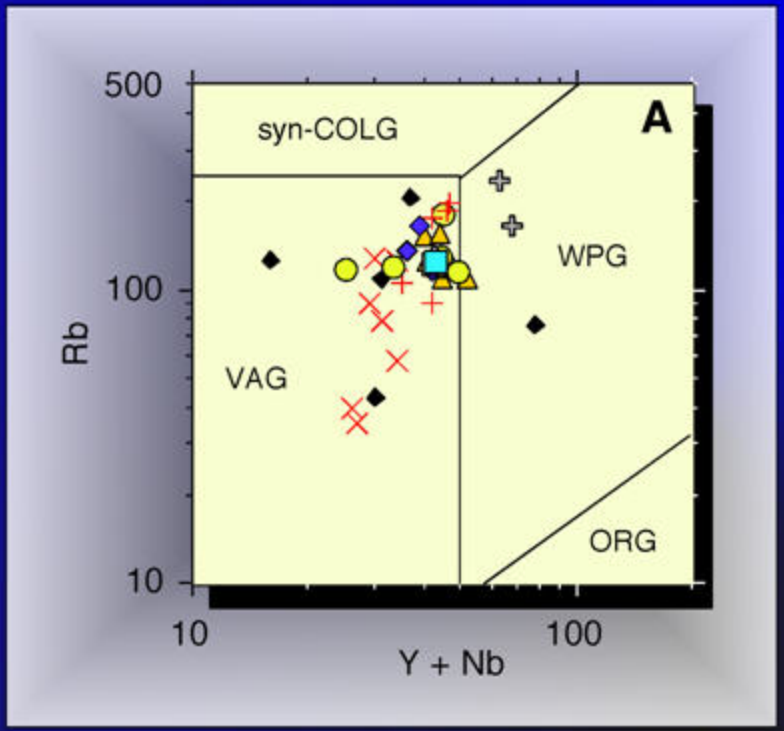
after Nesbitt, 1992



after Winchester & Floyd, 1977

Unkar

Intrusive Rocks



Ochoa Pt.
Comanche Pt.
Solomon Temple
Escalante Crk.
Shinumo Sst.
Hakatai Fm.
Bass Fm.
GGMS

COLG – collision granites

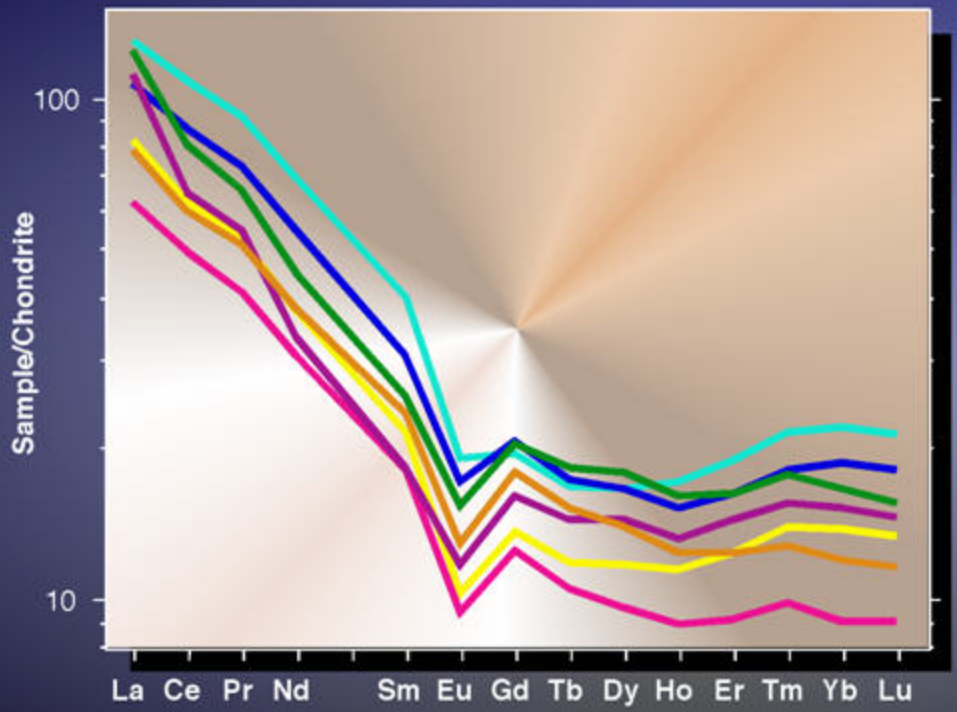
VAG – volcanic arc granites

WPG – within-plate granites

ORG – ocean ridge granites

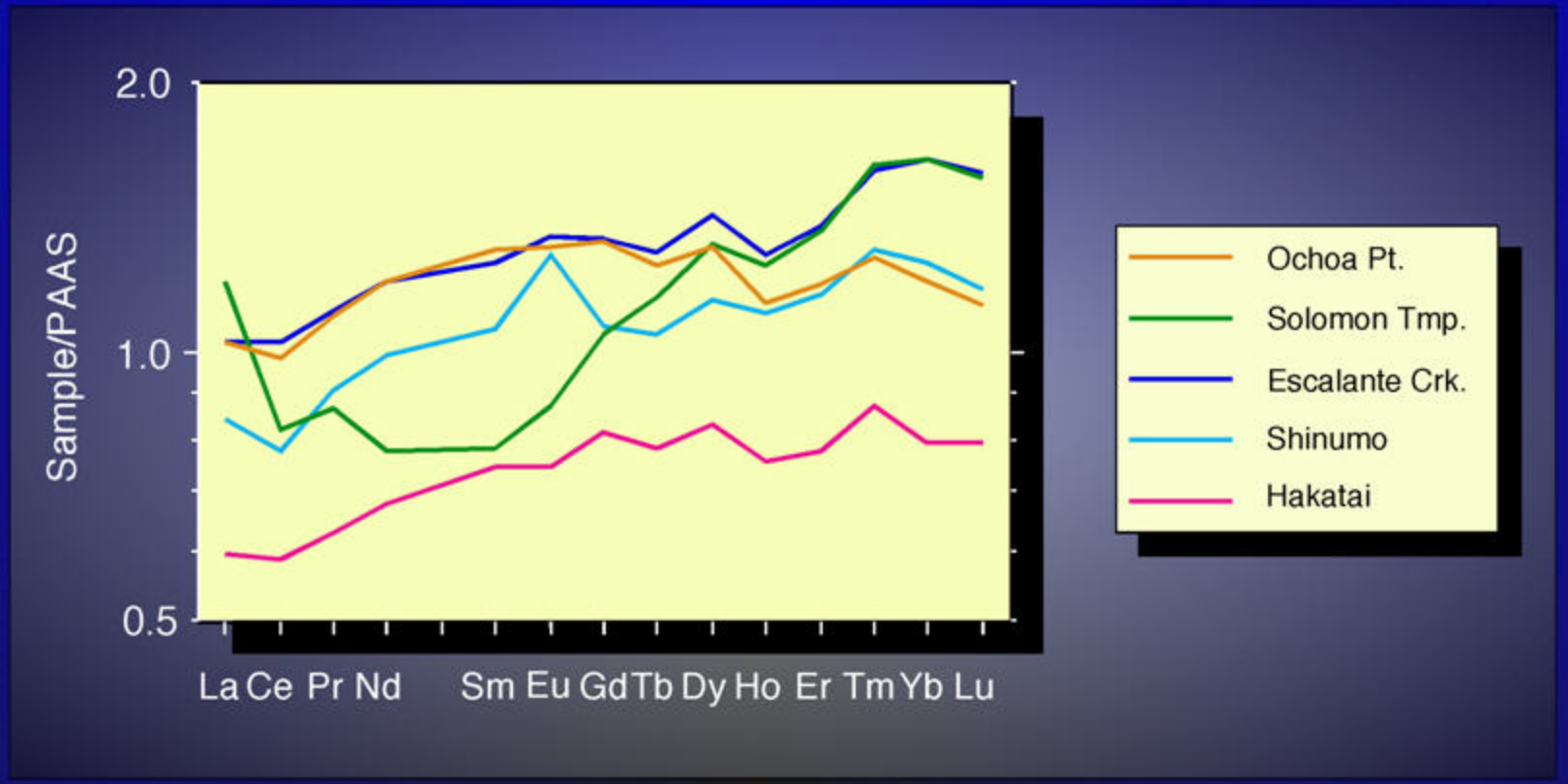
(after Pearce et al., 1984)

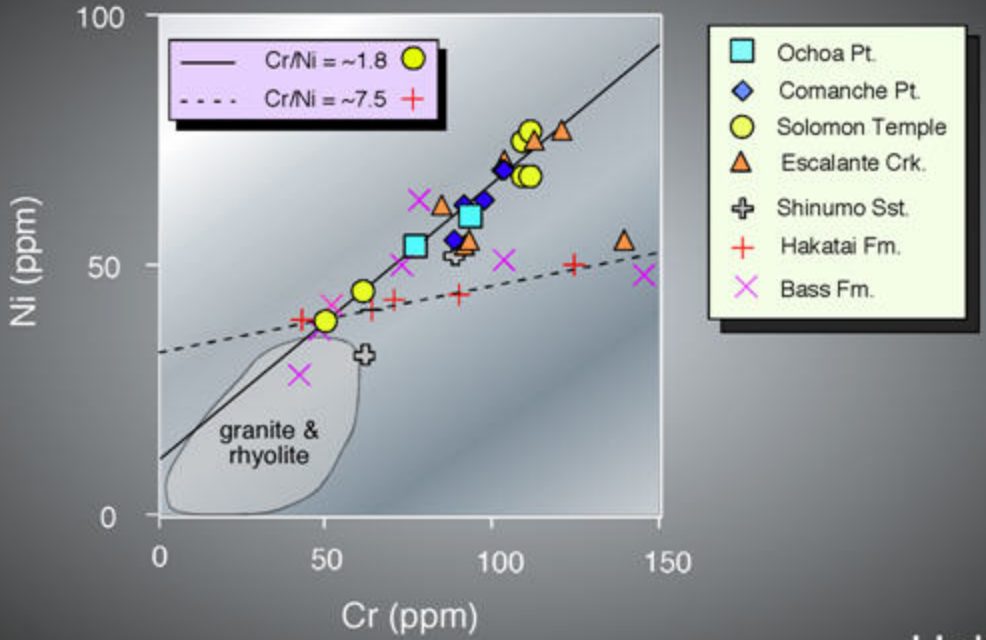
Unkar Bulk REE - Chondrite Normalized



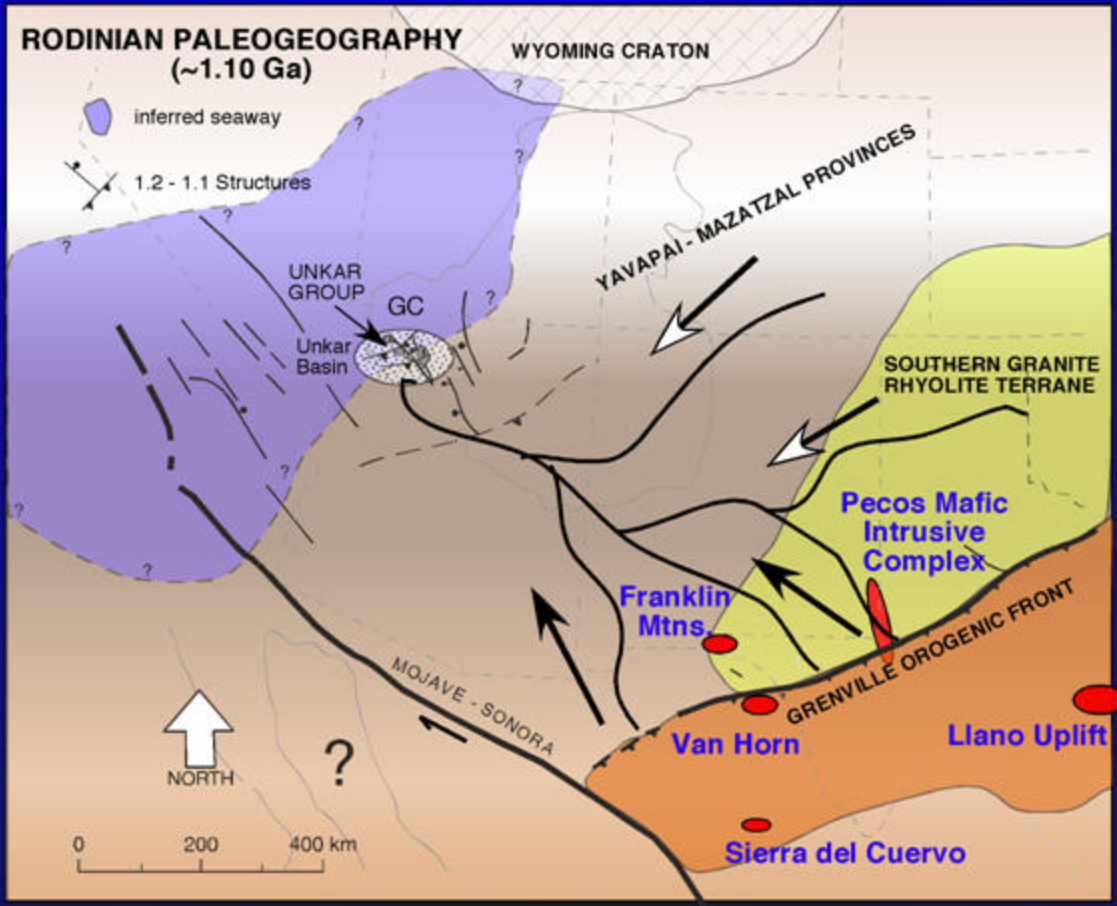
- Ochoa Point
- Comanche Point
- Solomon Temple
- Escalante Creek
- Shinumo
- Hakatai
- Bass

Unkar Bulk REE - PAAS Normalized




100
50
0
0
50
100
150
Ni (ppm)
Cr (ppm)
Cr/Ni = ~1.8
Cr/Ni = ~7.5
granite &
rhyolite
Ochoa Pt.
Comanche Pt.
Solomon Temple
Escalante Crk.
Shinumo Sst.
Hakatai Fm.
Bass Fm.

Unkar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Intrusive
Complex
Franklin
Mtns.
GRENVILLE OROGENIC FRONT
MOJAVE - SONORA
Van Horn
Llano Uplift
Sierra del Cuervo
NORTH
?
0
200
400 km

Conclusions

1. Zircon geochronology of sandstones links Unkar sediment to all tectonic provinces of SW Laurentia.

2. Bulk chemical trends indicate moderate weathering for most Unkar shales.

3. Major, trace & REE element abundances are consistent with sediment derivation from a mixture of granitic to mafic sources. Granite is the dominant component.