Relationships Between Primary Igneous Uranium Deposit and Molybdenum-Tin-Tungsten Deposit associated with Cenozoic Granitic Rocks in the western United States.

PRESENTATION, NORTHWEST MINING ASSOCIATION

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Thank you, Mr. Ward.

Uranium, Molybdenum, Tin and Tungsten are all glamour exploration targets. They are also incompatible elements with major rock forming minerals. This paper and the companion paper by Mutschler and others on Thursday, attempts to explore the relationships between deposits of these elements.

Projector on, please. (Slide B, point out E. Rockies Basin-Range.)

Primary (hydrothermal and magmatic) uranium deposits of Cenozoic age in the Eastern Rocky Mountains and Basin and Range Province of the western United States occur in both:

1) Peralkaline, and
2) Peraluminous

rhyolite and granite source rocks.

(Slide 13, Green Field.)

A few definitions are in order:

Peralkaline rocks are those in which the sum of molecular Na_2O+K_2O exceeds molecular Al_2O_3.

Peraluminous rocks are those in which molecular Al_2O_3 exceeds the sum of molecular Na_2O+K_2O.

On this slide, peralkaline rocks are those on the right of the vertical line, and peraluminous rocks are those on the left of the vertical line. Keep in mind the fact that these rocks all contain quartz.

ABSTRACT

for

NORTHWEST MINING CONVENTION

Relationships between primary igneous uranium deposits and molybdenum-tin-tungsten deposits associated with Cenozoic granitic rocks in the Western United States.

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Primary (hydrothermal and magmatic) uranium deposits of Cenozoic age in the Western United States have been generated by both peralkaline and peraluminous igneous source rocks. The peraluminous source rocks are chemically and petrographically similar to the source rocks of stockwork "granite" Mo-Sn-W deposits. The high-silica alkali rhyolite and granite source rocks of both U and Mo-Sn-W deposits share the following characteristics: 1) they meet Tuttle and Bowen's (1958) definition of granite; 2) they were emplaced coincident with, or just prior to, regional extensile tectonism; 3) they may have been derived from tholeiitic basalts; 4) the mineralized plutons and vents represent only small cupolas of bathotilhic magma chambers from which the ore elements were concentrated; and 5) F, Li, Mo, Nb, Rb, Sn, U, and W are enriched in these systems.

Certain spatial and chemical relationships between U and Mo-Sn-W deposits suggest promising exploration guidelines for both types of deposits: 1) a higher degree of igneous differentiation is required to produce economic Mo-Sn-W deposits than is needed to form economic U concentrations; 2) significant U concentrations may occur above Mo-Sn-W deposits; and 3) U is enriched in high Li plutons that are contemporaneous with, but laterally remote from, Mo-Sn-W deposits.

This apparent academic distinction has real economic significance because in peralkaline melts fluorine will remain dissolved in the melt rather than entering a water dominated hydrothermal phase where it could complex with Mo, U and other elements. Therefore, peralkaline systems tend to have higher background values of U and Mo while peraluminous systems tend to form ore deposits. Examples of U deposits in peralkaline and peraluminous rocks include:

1) Peralkaline source (and host) rocks
   McDermiit, Nevada
   Trans Pecos, Texas

2) Peraluminous source (and host) rocks
   Marysvale, Utah
   Lakeview, Oregon
   Nellie Creek, Colorado

The peraluminous source rocks for uranium deposits share many characteristics with the peraluminous rhyolites and granites which are the source rocks for "granite" Mo (Sn, W) systems in the western U. S., such as Climax and Henderson, Colorado; Questa, New Mexico; Pine Grove, Utah; Mount Hope, Nevada -- all Mo deposits --; Taylor Creek, New Mexico; and Izzenhood, Nevada -- Sn deposits.

The chemical characteristics that are shared by peraluminous source rocks for U deposits, and peraluminous source rocks for Mo (Sn, W) deposits include:

(Slide 1) Q-OR-Ab Diagram for Fresh Rocks

1) They are "granitic" rocks in the sense of Tuttle and Bowen (1958) because they contain > 80% normative quartz + normative albite + normative orthoclase. When these three constituents alone are normalized to 100% the granitic rocks contain > 20% normative quartz; > 20% normative albite and > 20% normative orthoclase; and plot in the colored area of the Q-Ab-Or

diagram shown.

2) These peraluminous igneous rocks were all emplaced during regional tensional tectonism: during Basin and Range faulting in the Great Basin; and during rifting along, say, the Rio Grande trench in the eastern Rockies.

3) All of these granites and rhyolites may have been derived from "tholeiitic" (or oceanic type) basalts -- and thus represent mantle melting, rather than crustal fusion.

(Slide C.) A-F-M Diagrams for Afar triangle vs Sierra Nevada (No copy of this included

This slide shows the differences -- tholeiitic and calc-alkaline

A = Na_2O+K_2O

F = FeO

M = MgO

Afar Triangle - Sierra Nevada.

Note: No economic primary U deposits are known which were derived from calc-alkaline (of Sierra Nevada) type rocks.

4) The fourth shared characteristic of these peraluminous rocks is that the mineralized plutons represent only small cupolas above batholithic magma chambers, in which the ore elements were initially concentrated. These cupolas, and their U or Mo (Sn, W) deposits occur in several settings:

a) Non-caldera settings; as for example:
The U deposits at Central District at Marysvale, Utah.
The Mo deposits at Climax, Henderson, or Mount Emmons, Colorado; or at Pine Grove, Utah; or at Mount Hope, Nevada.

(Slide 22.) Volcanic Caldera Setting

b) These plutons can also be found in resurgent caldera settings; as for example:

i) Small plugs along ring fracture zone of caldera:
U - Nellie Creek, Colorado
Mo - Horseshoe Bend, Colorado

ii) These deposits can also occur at the crest of the batholith in a resurgently domed caldera:
U - perhaps the deposits in the Mount Belknap caldera west of Marysvale, Utah.

iii) Plugs may lie along radial axes of arching extending outward from the caldera:
Mo - Ophir prospect on west side of Silverton Caldera, Colorado.

5) The last shared characteristic is that primary U deposits and Mo (Sn, W) deposits that formed from peraluminous rhyolites and/or granites all show unusual concentrations of the lithophite elements:

(Slide 18.) *Enriched Elements*

Be, Cs, F, Li, Mo, Nb, Rb, Sn, Ta, Th, U, W, and Y.

Although the sought after ore elements are Mo, Sn, U, and W these elements may have very limited dispersion halos above the actual ore deposit. F, Nb, Rb, and perhaps Li may be better prospecting guides at levels considerably above ore zones. The relationship of Rb with Ba and Sr may be particularly useful in recognizing potential source rocks for both U and Mo (Sn-W) deposits associated with granitic rocks.

(Slide 20.) *Rb-Ba-Sr Diagram*

In other words these rocks show an enrichment of Rb, and a concomittant depletion of Ba and Sr. The "good" rocks fall within the yellow area on this Rb-Sr-Ba plot which was developed by El Bousilli and El Sakary.

Certain spatial and chemical relationships between U deposits and Mo (Sn, W) deposits in peralkaline rhyolite or granite rocks suggest promising exploration guidelines for both types of deposits:

1) A higher degree of igneous differentiation and a higher degree of hydrothermal activity characterizes Mo-Sn-W deposits from U deposits:

In other words:

a) U deposits may have lower K/Na ratios than Mo-Sn-W deposits.

b) Uranium deposits usually do not have as extensively developed hydrothermal alteration halos as do Mo-Sn-W deposits.

(Slide 21.) *Level in the System*

2) Second, relationship found in peralkaline rocks is that significant U concentrations may occur above Mo-Sn-W deposits. There may be a vertical progression, or stacking of potential commodities as shown:

U	High
Sn	
Mo	Low

In other words, deep drilling through a U show may intersect Mo or Sn mineralization at depth.

Examples of this phenomena include:

a) The Marysvale Central district, Utah, where Cunningham and Steven of the USGS have suggested that a porphyry Mo system may underlie a productive U district;

b) The Majuba Hill district, Nevada, where high level U mineralization is progressively replaced at depth by first Sn, and at greater depth by Mo mineralization.

(Slide 17.)

3) Lastly, peralkaline rhyolite or granite plugs highly enriched in U often occur a few (2 - 30) km from porphyry Mo systems. In these cases both the Li-U plug and the Mo plug are of the same age and derived from the same underlying batholith.

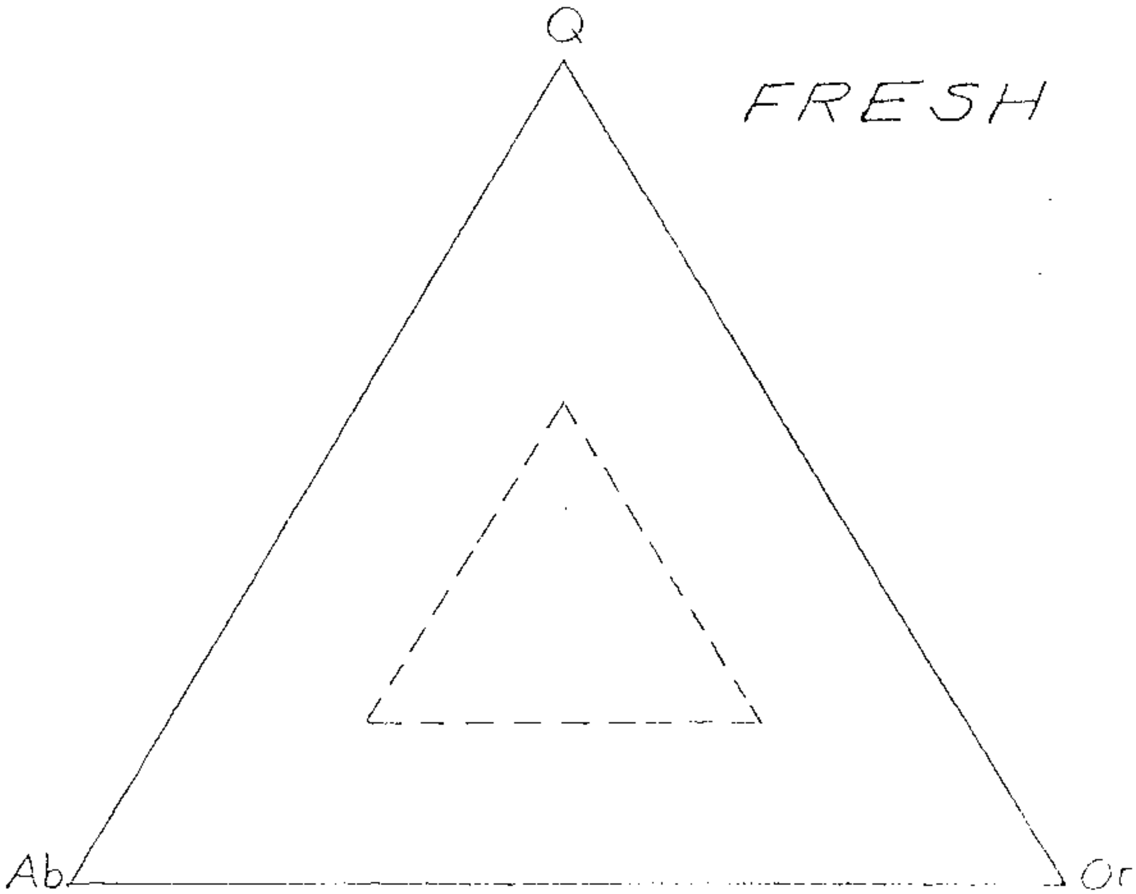
Examples of this curious relationship are:

	Li-U	
1)	Chalk Mt	Climax in Colorado
2)	Boston Peak	Mount Emmons, Colorado
3)	Granite Mountain	Big Ben, Montana
4)	Nellie Creek	Lake City Prospect, Colorado
5)	Possibly Blawn Mountain	Pine Grove, Utah

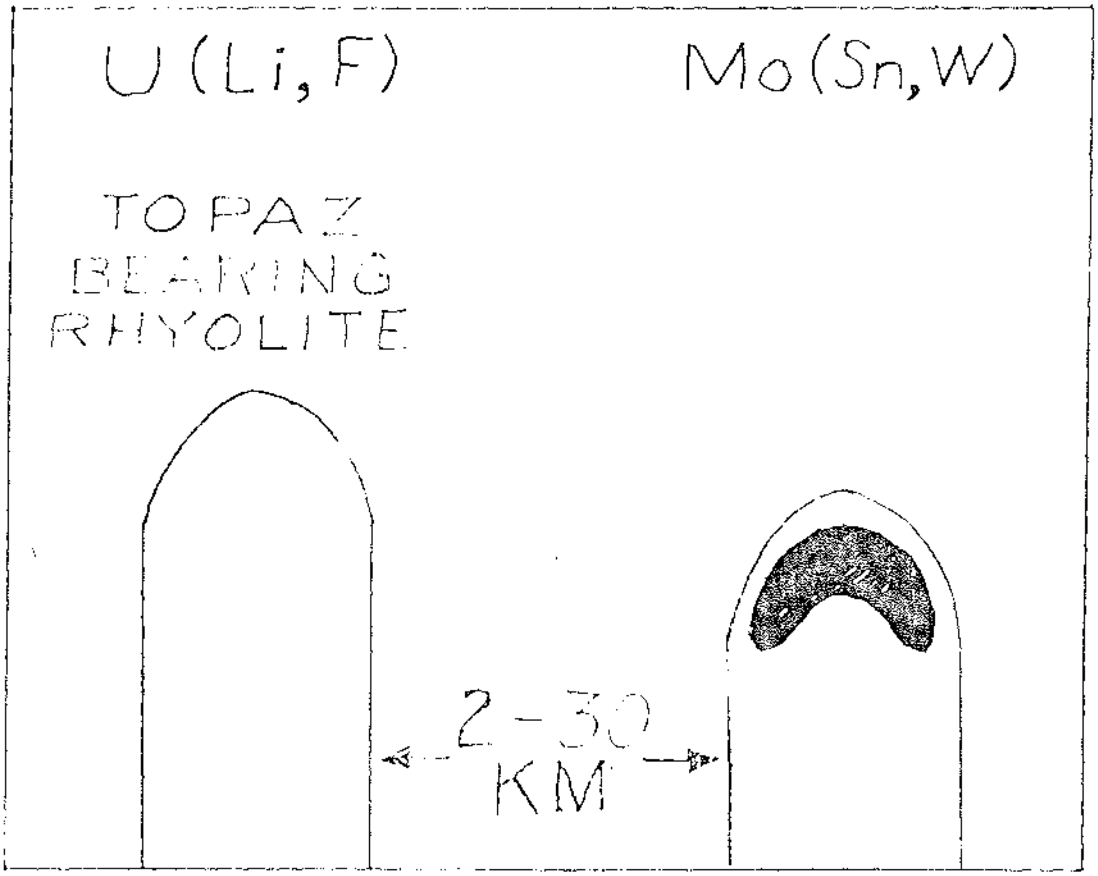
In summary, it could suggest that topaz bearing welded tuffs represent the vented phases of these systems. Therefore, attempting to determine the source vents for these welded tuffs in the Great Basin could be a useful approach to Molybdenum and Uranium exploration.

Thank you.

JAM:sh


Q
FRESH
Ab
Or

Slide 7

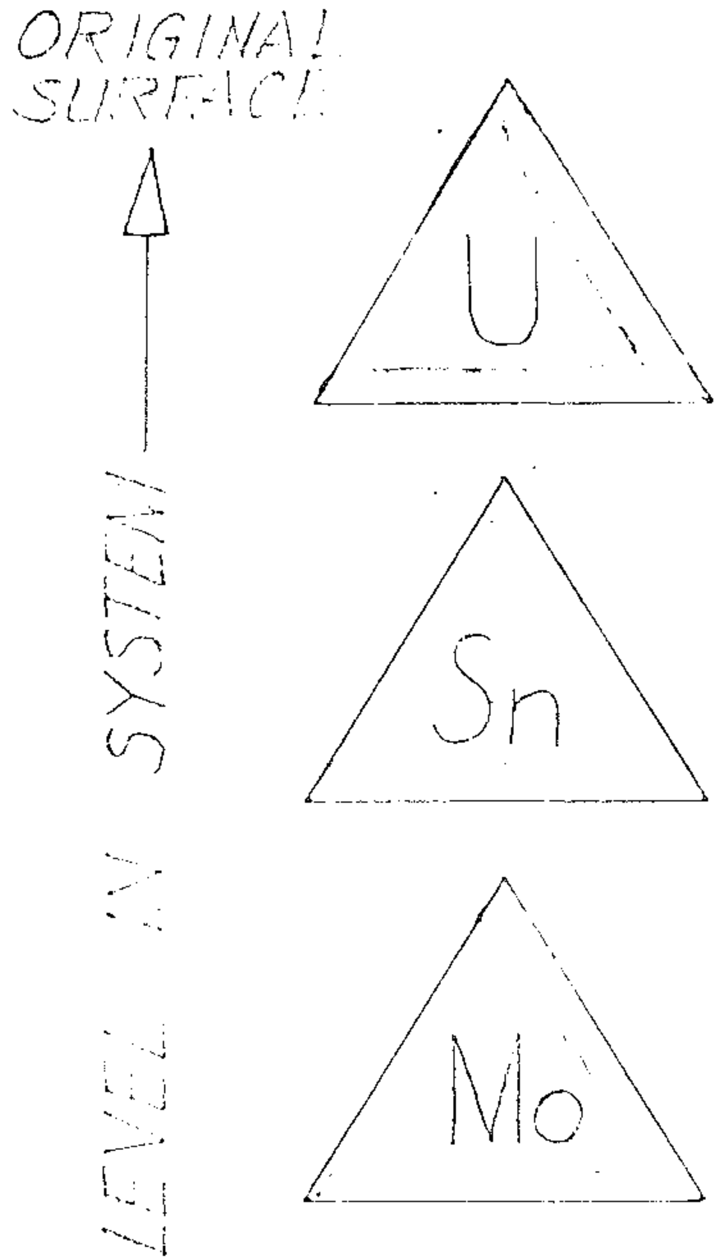


Slide (18)

ENRICHED ELEMENTS

Be	Cs	F	Li
Mo	Nb	Rb	
Sn	Ta	Th	
U	W	Y	

slide (21)



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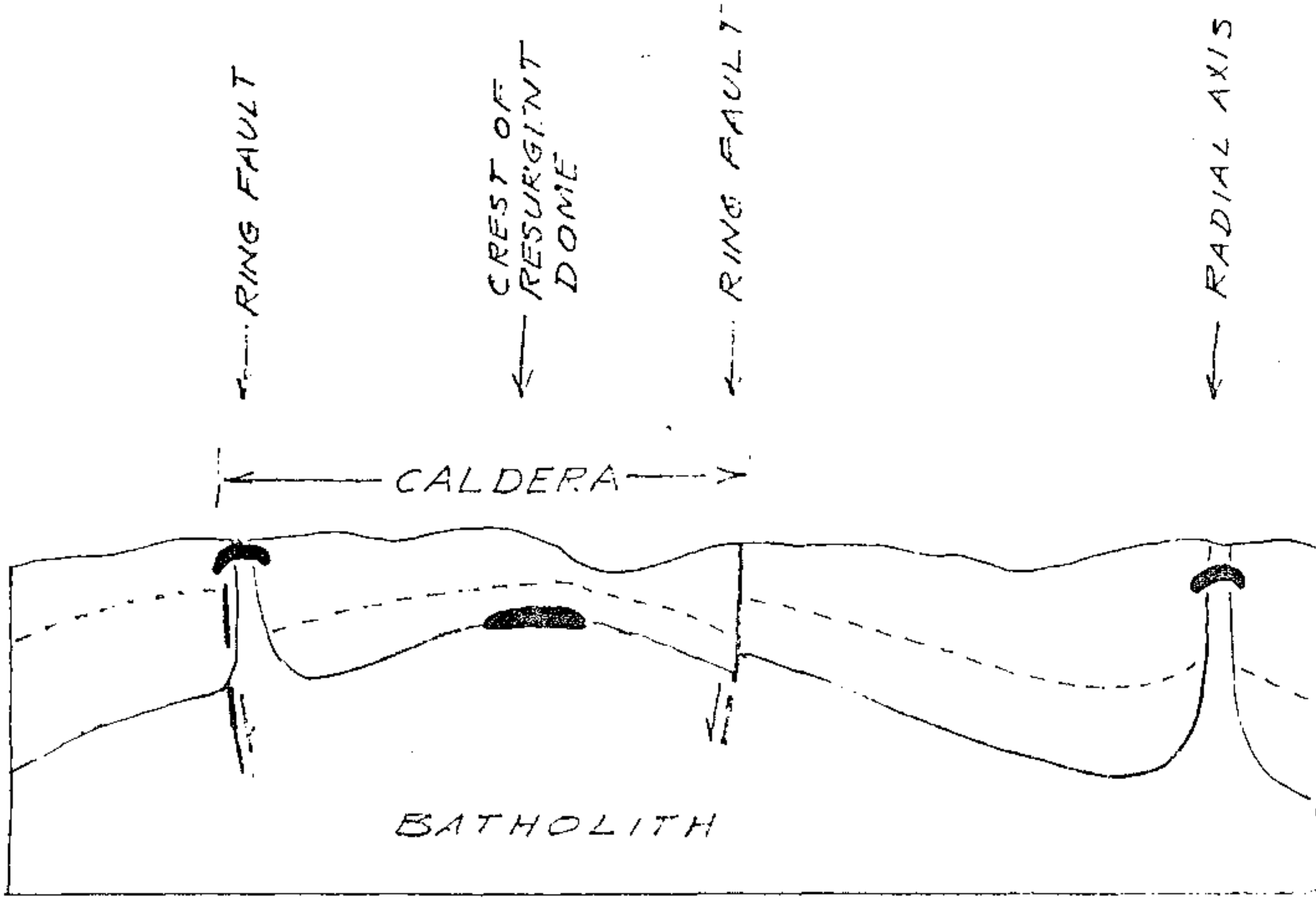
RING FAULT
CREST OF RESURGENT DOME
RING FAULT
RADIAL AXIS
CALDERA
BATHOLITH