Hydrovolcanism in the High Rock Caldera, Northwestern Nevada

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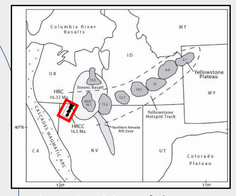
Abstract

Hydrovolcanic tuff cones are scattered throughout the southwestern interior of the High Rock Caldera, in northwestern Nevada. One tuff cone, informally named "the Bear Paws" was chosen for study. Aerially, the Bear Paws appear to be two cones, North and South Paw. The tuff cone erupted through caldera-filling lacustrine deposits and are likely to be the youngest magmatic event of the approximately 16 Ma High Rock Caldera, one of the oldest calderas along the NE-trending Yellowstone hotspot path.

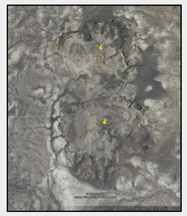
Stratigraphic and textural evidence reveals that the preserved tuff cone was emergent and subaerial. Only the innermost vent facies is preserved with the uppermost and exterior portions of the cone eroded away. There is one emergent, with two lower sub-facies, and one subaerial stratigraphic units surrounded by older, interbedded caldera fill and lacustrine deposits. The matrix of the cone has been moderately to highly palagonized and is weathered, with many volcanic clasts also showing secondary alteration. Hyaloclastite beds dip 45-68° towards the vent, vastly greater than typical tuff cones, which dip 20-25°. Soft sediment deformation, repeated slip failure back into the vents accounts for the steep dips with cementation by palagonitization occurring shortly after deposition. Dike swarms along the periphery of both cones appear to have slumped outward from the interior of the cone.

The Bear Paws are basaltic composition and erupted after siliceous and intermediate volcanism ended at the High Rock Caldera. The Bear Paws vented along a migrating vent from south to north, producing the double cone morphology. The migration may have followed the path of a dike. After the hydrovolcanic eruptions, fluctuating lake levels created two wave-cut platforms.

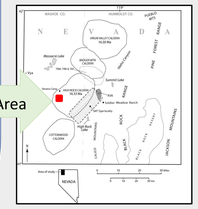
Geochemical and petrographic analyses show that the Bear Paws are the most mafic magmas erupted at the High Rock Caldera. The basalt (SiO_2 as low as 43%) appears to represent parental endmember composition along most major and trace element differentiation trends for the entire High Rock Caldera magmatic suite.



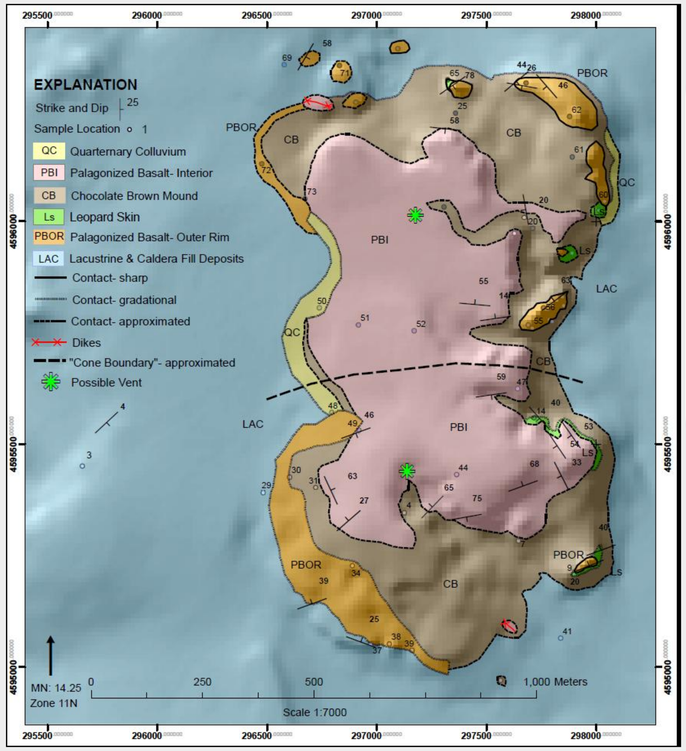
Location Map of the Yellowstone hotspot and High Rock Caldera



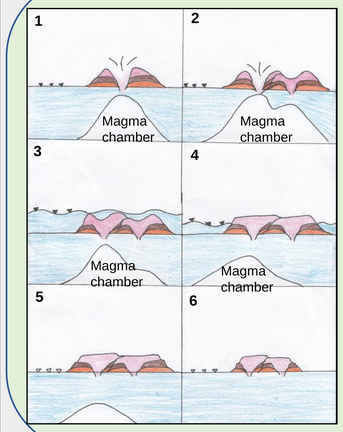
View of the Bear Paws from Google Earth



Location Map of High Rock Caldera

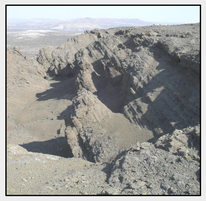


Eruption model

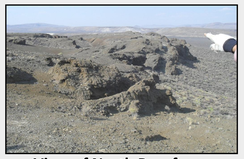


- South Paw erupts out of saturated lacustrine substrate subaerially. Slip failure into the vent occurs.
- Dike moves laterally to the northwest and North Paw erupts, overlapping part of South Paw. Repeated slip failure occurs into the vent.
- Lake levels rise to cover the Bear Paws.
- Lake levels decline and the top of the Bear Paws become a wave-cut platform.
- Lake levels decline again and reveal a second smaller wave-cut platform.
- Erosion of the outer cone occurs to present day Bear Paws formation.

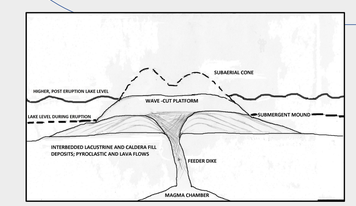
South Paw's steep dips in PBOR



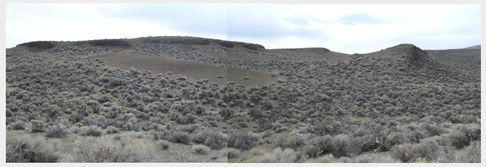
South Paw's steep dips in PBI



View of North Paw from South Paw



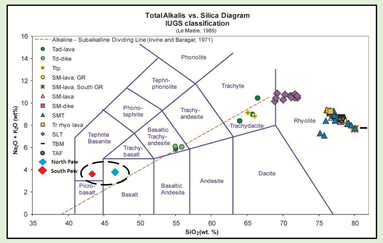
Cross section of a "typical" hydrovolcanic tuff cone eruptive sequence (White, 2001)

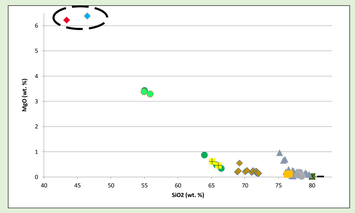


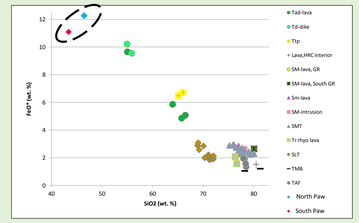
View of North Paw's wave-cut platforms from the northwest

Contact of CB sub-facies PBOR and leopard skin bedding

Geochemistry



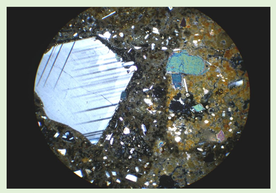




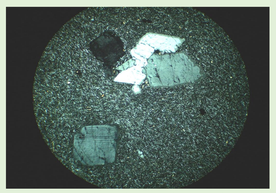
The Bear Paws young hydrovolcanic vents (circled) are the most mafic (basalts) of the entire mid Miocene High Rock Caldera magmatic suite. (Derived from Smith, 2011)

Petrography

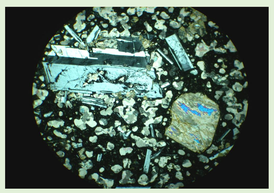
4x magnification, 5mm diameter



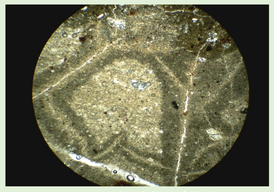
Palagonitization in South Paw dike



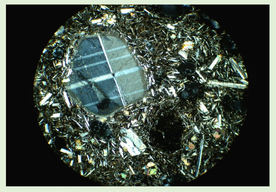
Accidental basaltic andesite clast



Secondary silica vug filling



Lacustrine and caldera fill deposits



North Paw dike

Hydrothermal alteration in PBOR

Bomb sag in PBOR

Accidental basaltic andesite clast

Juvenile magmatic cauliflower bomb

Conclusions

- The Bear Paws erupted long after the main caldera-forming silicious volcanism approximately 16 Ma by a basaltic dike trending N22°W
  - New magmatic upwelling in HRC magma chamber
  - Most mafic volcanism in HRC
- Petrographic analysis classified the Bear Paws as Hyaloclastite Palagonized Basalt
  - Emmergent and Subaerial hydrovolcanic lithofacies
- South Paw erupted before North Paw
  - Geochemical analysis classified South Paw as Basanite and North Paw as Basalt
  - Magma evolution per fractionation processes, double cone morphology without erosion, relatively rapid lateral vent migration
- Fluctuating lake levels created two wave-cut platforms with only the interior of the cones remaining today
  - Terraces are located at the top of the cones, commonly seen on North Paw
- Steep dips accounted for by repeated slip failure, soft sediment deformation and cementation by palagonitization

Acknowledgements to Robin Wham and Kevin Stevenson for being awesome field assistants and toting all my heart rocks