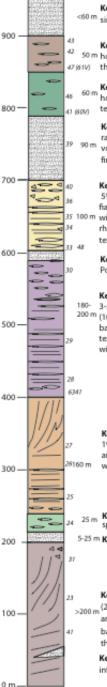
# Ar-Ar Age Correlation of the Elkhorn Mountain Volcanics and Base Metal Mineralization in the Ratio Mountain Quadrangle, Montana Thomas Horton

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### **Introduction**

The Ratio Mountain Quadrangle is located in Southwest Montana, East of the city of Butte. This quadrangle features two major geologic units; the Elkhorn Mountain Volcanics, a series of several ignimbrites of varying composition, and the Boulder Batholith, a large granite pluton that rose through the EMV. Previous studies in the region have focused on the Boulder Batholith, while comparatively little work has been done on the Elkhorn Mountain Volcanics. The most detailed work on the EMV was produced by Prostka in the 1960's, in which he described a series of five ignimbrite layers, underlain by a basal porphyry unit. An EDMAP grant was funded for Dr. John Dilles (OSU) during the summer of 2015 to map the EMV exposed in the Ratio Mountain Quadrangle in more detail and build on Prostka's work from the 1960's. The geochronology of the area is not fully understood; Dilles (OSU) and Dr. Kaleb Scarberry (Montana Bureau of Mines and Geology) have gotten two Ar-Ar ages on hornblende from mafic intrusions in the EMV, and have two mica samples from hydrothermal veins in the Boulder Batholith, but no geochronology had been conducted on the EMV prior to this year.

#### Measured Section of Elkhorn Mountain Volcanics, Middle Member, South Side of Ratio Mountain, MT



Kems, Volcanic, feldspar-rich poorly-sorted, poorly-bedded to planar-bedded sandstone, minor pebbly sandstone <80 m similar to unit KemD.

<sup>43</sup> KemE2, Moderately to poorly welded dacite to rhyolite ignimbrite with 10-15 vol. % plagioclase, clinopyroxene, <sup>42</sup> 50 m homblende, biotite, and opaques and <10% 5:1 flattened fiamme; sparse <1% lithics; vitroclastic and eutaxitic <sup>47</sup> (819) through-out. Base is conspicuously dark brown vitrophyre, and upper half is light grey-tan.

60 m KemE1, Moderately to strongly welded dacite tuff with 30 vol.% crystals of plagioclase, clinopyroxene, hornblende, biotite, and opaques. Contains S-10% S-10:1 flattened fiamme, and vitroclastic and eutaxitic textures; sparse lithics (<1%). Commonly green to white due to epidote, chlorite, and albite alteration.</p>

KemD, Tuffaceous sandstone, poorly sorted, poorly bedded on 1 to 50 cm scale. Bedding is planar to rarely gently cross-bedded, and shows both poor normal and inverse grading. Sandstone is coarse, with grains of volcanic lithics, plagioclase, mafics (pyroxene, homblende and biotite altered to chlorite), and opaques in a fine-grained matrix. Bulk composition is andesite.

KemC, Sparsely rheomorphic rhyolite ignimbrite, with 10-15% plagioclase, 1-3% 1-2 mm biotite, up 5% lithics at base to up to 5% lithics at top; commonly has largel (1-25 cm) and abundant (15-20%) famme, that are particularly visible in basal 5-30 m section of moderately welded vitroclastic/eutaxitic tuff <sup>m</sup> with with 4:1 compaction of fiamme. Central part has >50:1 stretched, planar banded rheomorphic ignimbrite; in upper half rheomorphic texture decreases upward and vitroclastic texture becomes prominent with <5:1 flattened fiamme, and more abundant lithics.</p>

Kems, Local volcanic conglomerate with andesite and dacite polylithic clasts in volcanic sandstone matrix. Poorly bedded and ungraded.

KemB, Partially rheomorphic dacite to rhyolite ignimbrite, with 10-20 vol.% crystals that include 7-12% plagioclase, 3-5% 1-2 mm biotite and trace(?) hornblende, opaques, <1% lithics; commonly has small (<1 cm) and abundant (10-20%) fiamme. A thin and local basal vitrophyre has eutaxitic structure, is overlain by >50:1 stretched, planar banded rheomorphic ignimbrite; in upper half rheomorphic texture decreases upward and vitroclastic texture becomes prominent with 5-10:1 flattened fiamme. Crystal content is ~20% in central section with more abundant biotite, less at top and bottom. Color, purple to brown.

KemA, Strongly rheomorphic crystal-poor (7-10 vol%) rhyolite ignimbrite, with 5-7% plagioclase, 1% biotite altered to chlorite, traces of opaques, and <1% lithics. A basal vitrophyre has eutaxitic structure, and is overlain by 100:1 stretched, planar-banded rheomorphic ignimbrite; upper half includes strongly welded rheomorphic ignimbrite with steep to gentle layering, and local flow-folding. Color is gray to white.

IS m KemAd, Dark green, poorly welded andesite ash-flow tuff with 25-30% plagioclase, 10% pyroxene and sparse biotite altered to chloritized, opaques, and10-15% 3:1 flattened, conspicuous 1-5 cm green fiamme

5-25 m Kems, Volcanic, feldspar-rich poorly sorted, planar-bedded sandstone, minor pebbly sandstone.

Keld, Massive to flow-banded dacite lava flows and domes >200 m in thickness, with abundant plagioclase >200 m (20-25%), and 10-12% augite, horblende, and minor biotite; 1-2% magnetite; Locally, basal and upper intervals are autobrecciated. Contains local andesitic enclaves. Some flowbanded units exhibit shallow and steeply dipping gray and purple flow-bands, 1-25 cm thick, that illustrate ramp structures. Dacites form paleo-topographic highs, suggesting domes. Kels, Volcanic, feldspar-rich poorly sorted, planar-bedded sandstone, minor pebbly sandstone intercalated with dacite lavas.

> Section by JHDilles, Nansen Olson, Thomas Horton, Ian Kallio, & Kaleb Scarberry Oregon State University, August, 2015-June, 2016

Fig. 1: Measured Section of EMV in Ratio Mtn. Quad

#### <u>Methods</u>

Two samples, NHO-15-31 and NHO-15-47, were selected from the measured section in the quadrangle and prepared for Ar-Ar geochronology at the Oregon State University Argon Geochronology Laboratory. Samples NHO-15-31 and NHO-15-47 were selected because they 1. Encompass the entire measured section in the southeast section of the quadrangle and 2. Have sufficient hornblende (1-3%) to separate for argon dating. Hornblende was the preferred mineral phase for dating, as it has a higher closure temperature and is fairly robust, meaning it is less likely to experience argon loss due to reheating after the emplacement of the Butte granite.

Samples were prepared by crushing to a small size fraction, 180-355 micrometers. After washing to remove dust, samples were separated by density using LST heavy liquid. After cleaning and drying, 4-5 mg of clean hornblende was handpicked from each sample and packaged for irradiation. Samples were irradiated at the Radiation Center at Oregon State University, and analyzed on the ARGUS VI multi collector mass spectrometer in the OSU Argon Laboratory.

Ar-Ar dating is based on the radioactive decay of

#### **Results and Discussion**

Both samples formed stable age plateaus. As expected, NHO-15-31 has a higher age than NHO-15-47, as it forms the bottom of the section. NHO-15-31 from the base of the section gave an age of 84.65±0.35 Ma, and NHO-15-47 from the top of the section gave an age of 83.72±0.31 Ma. These age dates help to paint a more complete picture of the Cretaceous arc magmatism that covered this area around 80 million years ago. Around 84 Ma, the Elkhorn Mountain Volcanics erupted as a series of ignimbrite flows over a time period of around one million years. After this eruption, the remaining magma source cooled more slowly beneath the surface, during this time mafic intrusions were emplaced throughout the area, one in the Ratio Mountain Quad was dated to 80.02±0.40 Ma. The Boulder Batholith is believed to have erupted around 76 Ma, and was giving off hydrothermal fluids until around 74 Ma, which results in the many metal deposits found in the region.

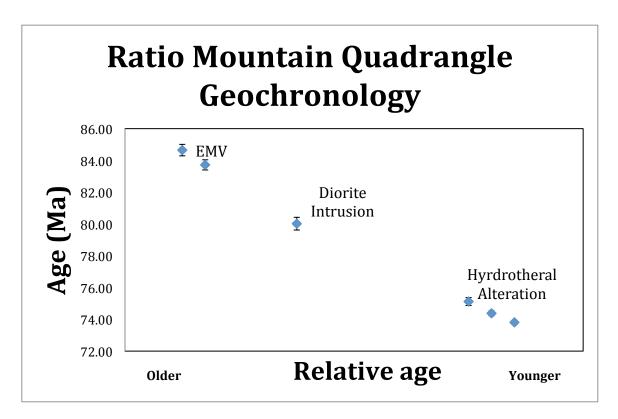


Fig.2: Ar-Ar Ages from various sources in Ratio Mtn. Quad

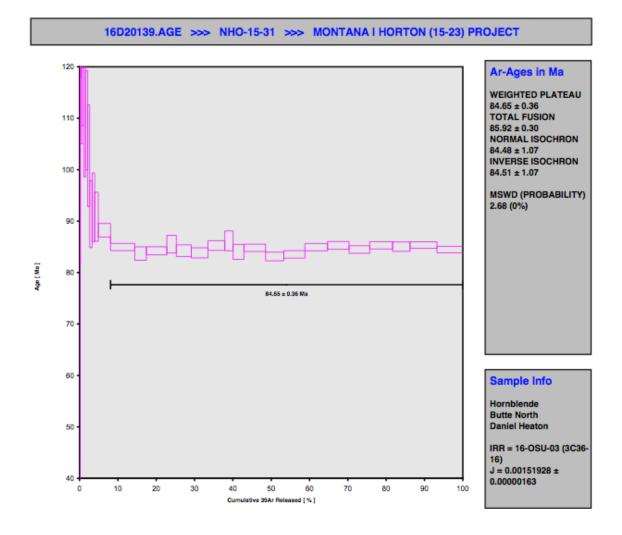


Fig. 3: Age Plateau for NHO-15-31 (Basal Dacite)

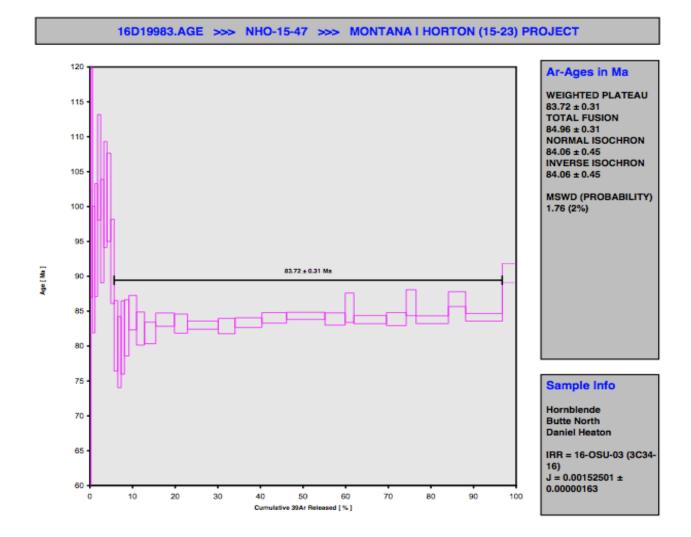


Fig. 4: Age Plateau for NHO-15-47 (Unit E)

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