Geochemical databases for characterization of K-metasomatized Tertiary units in central-western Arizona

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Materials accompanying this report are available at the AZGS Document Repository (repository.azgs.az.gov).

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Introduction

Tertiary sedimentary units in central-western Arizona are of interest because they evince evidence of potassium alteration and because they host Mn, Fe, and Cu mineral deposits. Little work has been done to characterize these units geochemically. Mineralization typically occurs as replacement ores and as disseminated to massive tabular ores (particularly the manganese deposits), and as fracture and fault filling deposits (Spencer and Welty, 1986). Mining districts in this province have produced copper, manganese, iron, and gold as well as lead, zinc, and silver accompanied by common gangue minerals, including: quartz, calcite, chlorite, and barite. Manganese production in the Buckskin-Rawhide Mountain area totaled approximately 24 million pounds of Mn; the Artillery Mountains district yielded more than 93 million pounds making it the largest manganese producer in the United States (Spencer and Welty, 1986). Associations between K-metasomatism and detachment-related mineralization have been suggested in the southwestern United States (Chapin and Glazner, 1983; Brooks, 1986; Chapin and Lindley, 1986). Alteration due to infiltration K-metasomatism, often associated with hematization, was the dominant process responsible for mineralization in the Tertiary strata. Similar alteration assemblages indicating K-metasomatism (secondary K-feldspar-quartz-calcite and hematite) have been previously mapped in central-western Arizona south to Picacho Peak (Brooks, 1986), north to the Artillery Mountains, and west to the Whipple Mountains, spanning over 40,000km^2.

I acquired data to examine Tertiary sedimentary units from mineral districts where previous studies had confirmed metasomatic alteration in surrounding volcanic units (Duncan 1990; Brooks, 1986; Chapin and Lindley, 1986; Hollocher et al., 1994; Roddy et al., 1988), and from where intense hematitic alteration was observed in close proximity to detachment faults. Within the overall study area which encompassed 40 x 70 km, nine field areas were selected, shown as red boxes in Figure 1. These range in size from 1 – 5 km^2 each and include Miocene sandstone and conglomerate units of the upper plate of the Buckskin-Rawhide Mountain and Plomosa Mountain detachment faults. Mining districts in these areas include Pride, Planet, Swansea, Clara, Bullard, Northern Plomosa, and Artillery.

Two datasets are included as shapefiles in this publication, as well as Excel files containing the raw data, and a PDF file of the data points overlain onto a geologic map of central-western Arizona. Each of the data points shown on the map represents a full analyte suite, which could include more than 40 elemental analyses. The first dataset (represented by blue data points, Figure 2) are geochemical analyses which were collected in the field using a handheld Thermo Scientific Niton XL3-series X-ray fluorescence (XRF) analyzer in all nine study areas. A total of 415 spot analyses were performed. The raw data from XRF analyses is given in Table 1. The instrument automatically calculates a standard deviation (or tolerance) of measurement for each individual elemental analysis obtained, given at a 2 sigma confidence level. The tolerances for XRF analyses per individual element were averaged over the XRF dataset, and are also given for each element in the Excel table. For this study, typically several XRF readings were taken generally within a 10 cm area of each other to assess the variability in single spot analysis on apparently uniform beds or outcrops. The grouped readings were used to indicate samples for further analysis (i.e., whole rock geochemistry).

In addition to the XRF dataset acquired for this study, a subset of units from all study areas were sampled for whole rock analysis. This is the second dataset (Table 2) and is represented by red data points in Figure 2. Activation Labs of Ontario, Canada, performed whole rock analyses on 28 samples using a lithium metaborate/tetraborate fusion technique for Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Preliminary readings from the field-portable XRF were used to identify units for further analysis (i.e., highest K readings), from which samples were taken for whole rock analysis. Rock samples were first cut and polished to remove weathered surfaces, then sent to Activation Labs for sample preparation (crushing) and analysis. Samples were run on Thermo Jarrell-Ash ENVIRO II ICP or a Varian Vista 735 ICP, which are calibrated to USGS and CANMET certifications. Whole rock analyses with the detection limits per analyte or element provided directly from Activation Labs are reported in Table 2.

Databases

Included shapefiles are in a NAD 1927 projected coordinate system and using the GCS_North_American_1927 geographic coordinate system projection. The data in the shapefiles is identical to that reported in Tables 1 and 2. Generalized location information for the study areas are given in Figure 1 and abbreviated in the datasets as “SA”. Geochemical analyses were acquired from upper plate units unless specified as “lower plate” under the “Location” field heading. Lithology abbreviations are as follows: ss = sandstone; vol = volcanics.

(1) **XRF.shp** Data in this shapefile stems from Table 1 and appears as blue points in Figure 2. These are the raw data values obtained in the field through use of the Thermo Scientific Niton XL3-series x-ray fluorescence (XRF) handheld field analyzer. All units are ppm. Blank cells in the Excel table indicate below the level of detection (LOD); these are represented in the shapefile attribute table as “0”. LOD for elements measured were given to the authors from Thermo Scientific at a 3 sigma, or 99.7% confidence level (Table 1, column B). The limit of quantification (LOQ) is usually the value considered usable for any given element, which is given by Thermo Scientific as 3 times the LOD for the instrument. Tolerance (standard deviation) is displayed when each measurement is taken; Table 1, column B gives the average tolerance per element over the entire dataset. These are at a 2 sigma confidence level.

(2) **WR.shp** Data in this shapefile is given in Table 2 and shown as red points in Figure 2. Raw data values obtained in indicated sample locations as analyzed by Activation Labs of Ontario, Canada using a Inductively Coupled Plasma Mass Spectrometry (ICP-MS) on whole rock powders prepared with lithium metaborate/tetraborate fusion. Levels of Detection (LOD) are as given by Activation Labs; total uncertainty at the detection limit is + 100%, ± 20% at 10 times the detection limit, and ± 5% at 100 times the detection limit (Table 2, columns B, C, and D).

Tables

Table 1. Raw data values from x-ray fluorescence (XRF)

Table 2. Raw whole rock Inductively Coupled Plasma Mass Spectrometry (ICP-MS) data values

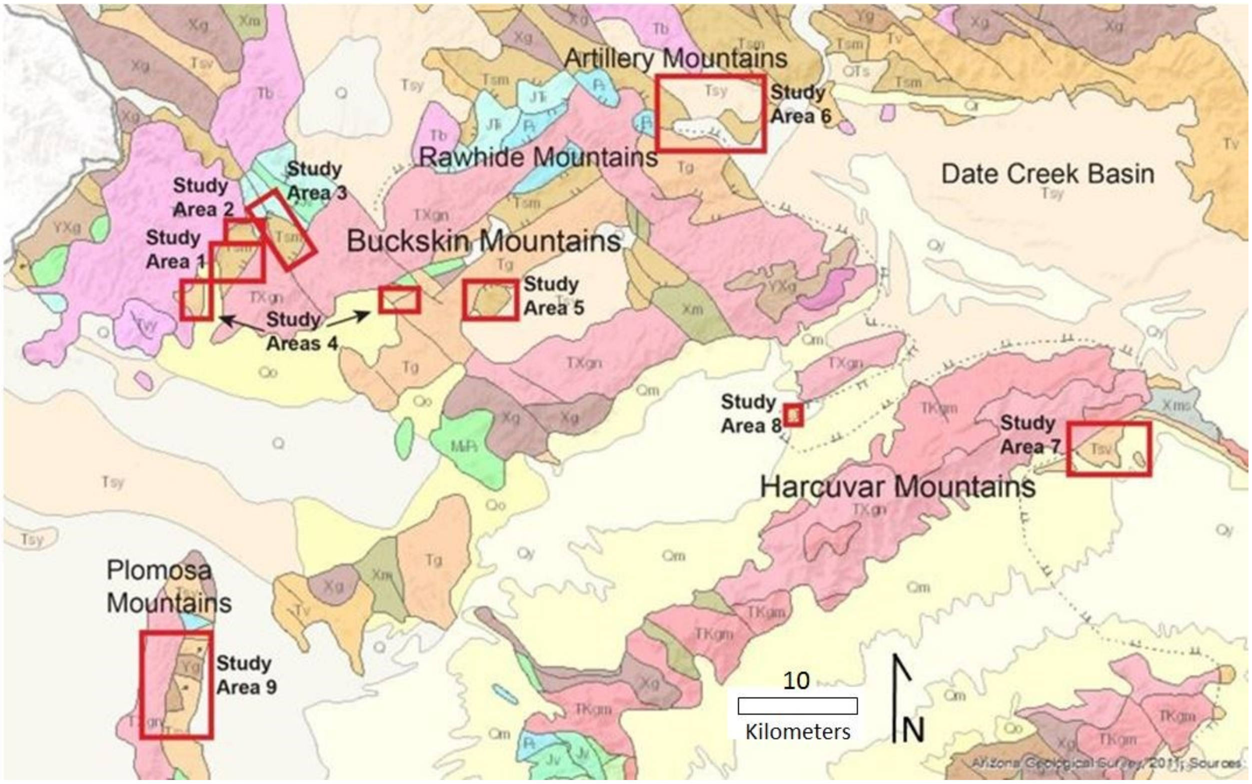

Figure 1. Nine individual study areas, each bordered by red boxes. Study areas encompasses units mapped as Pliocene to middle Miocene deposits (Tsy), middle Miocene to Oligocene sedimentary rocks (Tsm), and middle Miocene to Oligocene volcanic and sedimentary rocks (Tvs) (Arizona Geological Map 35; Reynolds, S.M., et al, 2000). The broken line with double-tick marks indicate detachment faults. Major mountain ranges and basins shown. Base map taken from Arizona Geological Map 35; AZGS DGM 17, scale 1:1,000,000.

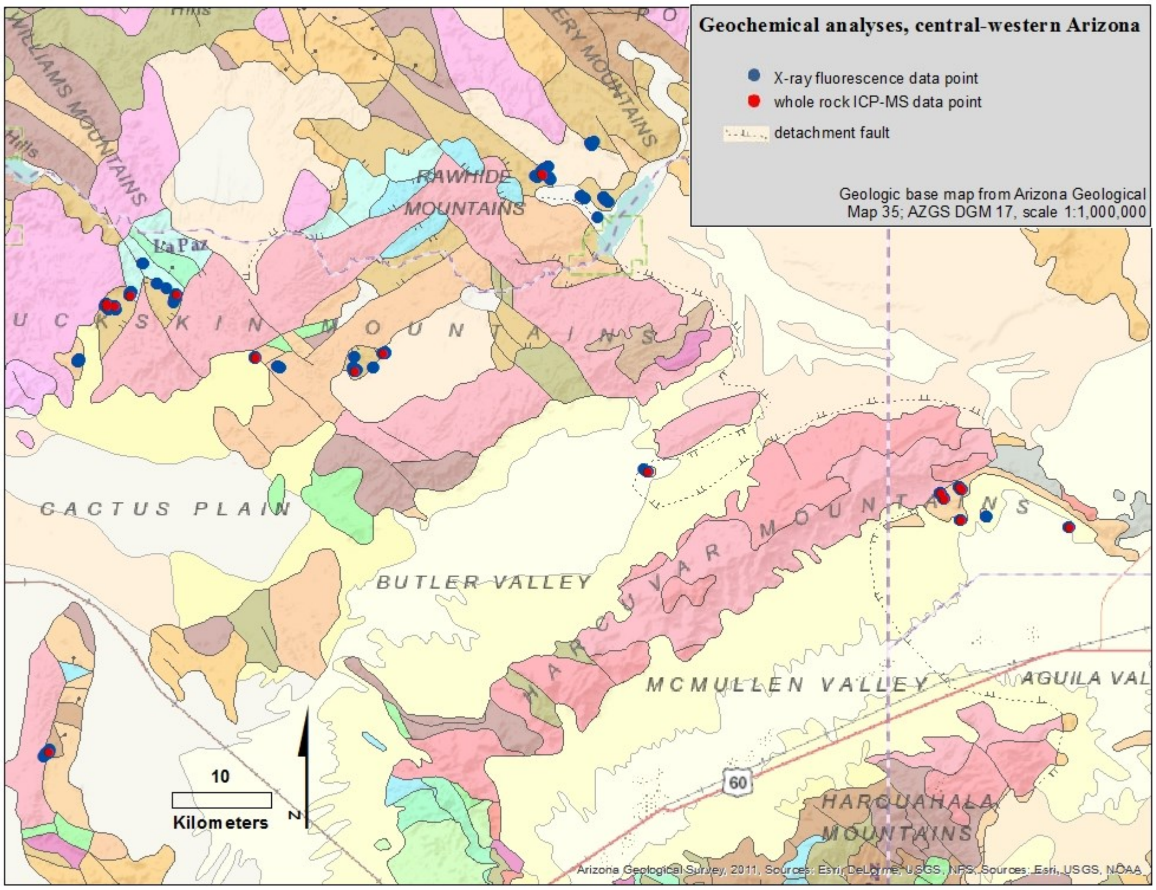

Figure 2. Geologic map of central-western Arizona showing representative locations of geochemical analyses for XRF and whole rock ICP-MS datasets. Broken line with double-tick marks indicate detachment faults. Major mountain ranges and basins shown. County lines are shown as gray broken lines. Paved roads shown as black and red solid lines. Base map taken from Arizona Geological Map 35; AZGS DGM 17, scale 1:1,000,000.

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