**COMPARING AND RECONCILING TRADITIONAL FIELD AND PHOTOGEOLOGIC MAPPING TECHNIQUES: LESSONS FROM THE SAN FRANCISCO VOLCANIC FIELD, ARIZONA.** J.A. Skinner, Jr.[1], D.B. Eppler[2], J.E. Bleacher[3], C.A. Evans[2], W. Feng[3], J. Gruener[2], D.M. Hurwitz[5], B. Janoiko[2], and P. Whitson[2], [1]U.S.Geological Survey, Astrogeology Science Center, Flagstaff, AZ 86001; (jskinner@usgs.gov).[1]NASA-Johnson Space Center, Houston, TX 77058. [3]NASA-Goddard Spaceflight Center, Greenbelt, MD 20771,[4]Departments of Geology and Astronomy, Smith College, Northampton, MA, [4]Lunar and Planetary Institute, Houston, TX 77058.

**Introduction:** Cartographic products and – specifically – geologic maps provide critical assistance for establishing physical and temporal frameworks of planetary surfaces. The technical methods that result in the creation of geologic maps vary depending on how observations are made as well as the overall intent of the final products [1-3]. These methods tend to follow a common linear work flow, including the identification and delineation of spatially and temporally discrete materials (units), the documentation of their primary (emplacement) and secondary (erosional) characteristics, analysis of the relative and absolute age relationships between these materials, and the collation of observations and interpretations into an objective map product. The "objectivity" of a map is critical cross comparison with overlapping maps and topical studies as well as its relevance to scientific posterity. However, the "accuracy" and "correctness" of a geologic map is very subject to debate. This can be evidenced by comparison of existing geologic maps at various scales, particularly those compiled through field- and remote-based mapped efforts.

Our study focuses on comparing the fidelity of (1) "Apollo-style" geologic investigations, where typically non-geologist crew members follow static traverse routes established through pre-mission planning, and (2) "traditional" field-based investigations, where geologists are given free rein to observe without pre-planned routes. This abstract summarizes the regional geology wherein our study was conducted, presents the geologic map created from traditional field mapping techniques, and offers basic insights into how geologic maps created from different tactics can be reconciled in support of exploratory missions. Additional abstracts [4-6] from this study discuss various exploration and science results of these efforts.

**Regional Geology:** The San Francisco Volcanic Field (SFVF) encompasses ~4,800 km$^2$ of the southern Colorado Plateau and contains gently sloping Paleozoic to Mesozoic stratified rocks that are superposed by Cenozoic basaltic and andesitic volcanic cones and flows [7-9]. The weakness of the underlying sedimentary strata (relative to capping volcanic rocks) has resulted in a broad-scale butte and mesa topography. The geology of the SFVF has been detailed at various scales using both field- and remote-based observations and relative age assessments [7-9]. The most comprehensive geologic map of SFVF is provided at 1:100,000 scale by Billingsley et al [9], which itself is a compilation of and revision of multiple 1:24,000 scale maps as associated topical studies [7-8].

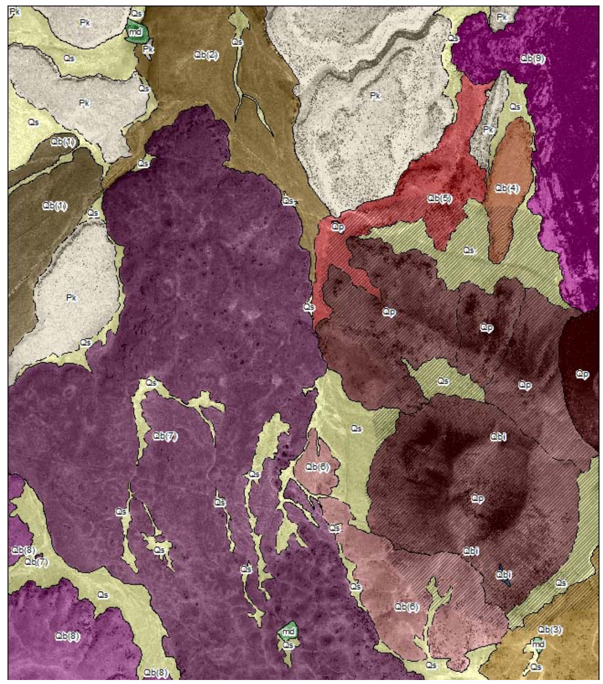

**Figure 1.** Geologic map of the V7504 field area, San Francisco Volcanic Field, north-central AZ. A chief question of the field mapping was the nature and evolution of the V7504 vent complex, identified here in brown.

**Local Geology:** The local region of interest in the SFVF consists of a ~25 km$^2$ area located southwest of SP Crater and Flow (**Fig. 1**). The region includes a ~175 m high, 2 km long hummocky and sublinear ridge located north of a 166 m tall, 670 m wide ovoid cone (identified as V7504 in [5]). Multiple, dark-toned lava flows extend from and/or surround these edifices, with marginal landforms indicating northeastward emplacement direction. Volcanic edifice and flow units are superposed and infill north-south valley and canyon systems within the relatively flat-lying Permian Kaibab limestone. Light-toned surficial deposits variably cover all units within the region, including shallow, narrow drainages within and along the margins of flow units. Low brush and scrub vegetation is common within the region. This region served as part of the traverse envelope for the DRATS 2010 field campaign, for which local observations supported the creation of a comparative geologic map for this study [see summary by 7].

We identify 13 discrete geologic units within the region of interest (**Table 1**). This includes one pyroclastic (vent) unit, nine flow units, and one volcanic intrusion unit. Volcanic units comprise the bulk of the map area, though differentiation between discrete lava flows as well as pyroclastic (vent-forming) units is complicated by varying degrees of surficial cover. The mapping illustrates a complex evolution of V7504, potentially due to migrating north-south eruption as well as breach, pull-apart, and eruption along the western edge of the northern ridge (**Fig. 1**). Compositional similarities between basalt lavas within the region appear to connect several flows to a common magmatic body.

| Unit | Outcrops | Area (km2) |
|---|---|---|
| Qs | 28 | 3.2 |
| Qp | 6 | 3.9 |
| Qbi | 3 | 0.008 |
| Qb(9) | 1 | 1.4 |
| Qb(8) | 3 | 0.7 |
| Qb(7) | 2 | 7.1 |
| Qb(6) | 2 | 1.0 |
| Qb(5) | 1 | 0.7 |
| Qb(4) | 1 | 0.3 |
| Qb(3) | 1 | 0.5 |
| Qb(2) | 1 | 1.3 |
| Qb(1) | 2 | 0.6 |
| Pk | 8 | 3.1 |

**Table 1.** Unit summary for geologic map of V7504.

**Discussion.** We are just beginning to conduct direct comparisons of our recently completed map products. However, even cursory review indicates that there are limitations to producing accurate and reliable geologic maps for operational planning. In the modern era, the prevalence of various remote data sets effectively restructures more traditional field mapping tactics. Efficiency requires that traditional field and photogeologic mapping techniques be conducted in tandem. However, there is a paucity of comparative data that can help guide the integration of these potentially disparate approaches. This paucity is particularly relevant to the planning and execution of exploratory missions to extraterrestrial bodies, which rely on a careful balance of both remote and *in situ* observation.

Existing maps for the SFVF – and their resultant collations – nicely establish regional and local geologic details regarding the evolution of volcanism along the southern Colorado Plateau. They do not – nor were they intended to – capture subtle differences in how individual cones and flows were emplaced and subsequently modified. The very local and very subtle geologic characteristics of individual volcanic vents and flows – regardless of the area – do not impede an understanding of local to regional geologic environments, mostly because the broader area is physically accessible (supporting further field-based studies). However, these local-scale relationships are absolutely critical to the successful execution of scientific investigations that are resource sensitive, including those that guide *in situ* exploration of extraterrestrial surface by human and/or robotic observers.

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