REPORT

QAX̂UN SETTLEMENT ON A SULFUR DEPOSIT (RAT-00162), LITTLE SITKIN ISLAND, WESTERN ALEUTIANS, ALASKA

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ABSTRACT

RAT-00162 is a long-term sulfur acquisition site used repeatedly by Qax̂un beginning at least 600 years ago and continued by Russian colonizers in the AD 1700s. The site includes 22 features and feature clusters in traditional Unangam and colonial styles visible along the edge of an eroding bluff edge on northwestern Little Sitkin Island. An orthorhombic sulfur solfatara deposit (elemental sulfur) is present less than 1 m below the surface of the site. Sulfur has myriad uses and is described as a weaponry ingredient in Unangam traditional knowledge. Sulfur would have been an important resource with potential commercial value for Russians. Site evidence suggests both groups exploited the sulfur for personal use and/or trade opportunities.

SULFUR RESOURCE EXTRACTION IN THE ALEUTIAN ISLANDS

Large coastal village midden sites and smaller upland occupation areas developed by Unangam ancestors through the past several millennia are ubiquitous in the Aleutian Islands. These archaeological sites tend to be multiple occupancy areas that ancestral Unangax̂ utilized for a diversity of daily life and resource extraction activities simultaneously and/or sequentially over hundreds to thousands of years. Defining the specific purpose of an occupied place for any given time period is rarely possible and may be an unreasonable query given that these were people's fully inhabited home spaces. However, occasionally a place was occupied for a predominant purpose, such as fishing camps, which are typically special-use occupations throughout the Arctic. We believe we have identified another type of specific resource acquisition locale on Little Sitkin Island in the Rat Islands, a sulfur acquisition or mining site (RAT-00162).

The Aleutian Islands do not have a strong research tradition for raw material resource extraction processes and sites. McCartney (1977) stated the importance of raw material resource acquisition in his general mobility and landscape use models. Unangam ancestors in the Aleutian Islands made effective use of biological resources: fish, sea mammals, birds, and plants all featured as critical raw materials, and all have been subject to research across the archipelago. Lithic raw material and mineral source exploitation has not been adequately studied at all (but see Cooper 2003; Jew 2007; Mason and Aigner 1987; Nicolaysen et al. 2012; Speakman 2012). We assume that Unangam ancestors had mineral resource expertise analogous to their knowledge of biological resources, even if few specifics are well-known today.

RAT-00162

Archaeological site RAT-00162 on Little Sitkin Island is providing new and interesting information about raw material resource exploitation in the region. Rat Islands

Research Project personnel mapped site features and performed a small test excavation on the rapidly eroding site during a four-hour site survey in June 2014. The site is in close proximity to abundant and easily accessible sulfur deposits. Site features include shapes and distributions of small traditional ovate, semisubterranean depressions, as well as probable Russian-era features, and a few anomalous features that defy easy characterization. We hypothesize that the occupants of RAT-00162, Unangam ancestors called Qax̂un, were focused on sulfur extraction and built small dwellings for the duration of their stays on Little Sitkin. We identified the remains of two Russian-style structures, which suggest use of the sulfur deposit during the Russian colonial era.

SULFUR USE

Sulfur is an element with fundamental utility across all modern industrial processes in a wide spectrum of categories. Orthorhombic sulfur, a stable material at normal atmospheric temperatures (Jefferson Lab 2019), can be mined at great human and environmental cost when it is deep below the surface, or easily in the rare circumstances of solfatara deposits close to the ground surface in volcanic landscapes. The sulfur deposit below RAT-00162 is a sublimation deposit formed by fumaroles that is remarkably easy to access, with no need to venture into an active volcano or a deep mine (Gittinger 1975:1111). The personal cost to value acquired ratio would have been quite low.

Sulfur has been used medicinally across cultures as an antimicrobial, antibacterial, anti-inflammatory, and a laxative (Bailey et al. 2001; Cobb and Goldwhite 1995; Environmental Literacy Council 2019; Knapp 1996; Mehler 2015; Stwertka 2002). It is and has been used to treat skin disorders of various kinds, and it is a known aphrodisiac (Mehler 2015; Rätsch and Müller-Ebeling 2013). It is a preservative, used in dried food products (including fruits and herbs, which can be smoked in it) and preserved skins (Hook 2013). Sulfur is used to create surprisingly purple pigments (Mehler 2015). It acts as a fumigating pesticide and a fertilizer. It is a fire starter, a main ingredient in gunpowder, and can be manufactured into a poisonous mustard gas (Mehler 2015; Strehlow 1994).

SETTING

RAT-00162 is on a peninsula between William Cove to the north and an unnamed bay to the south on the west side of Little Sitkin Island (Fig. 1). The site is on a bluff above the south bay, which has a dense reef system that wraps around to the west and north. The north bay provides an unimpeded deep-water approach to the site landscape, only 400 m away from the site. The site's location is unexceptional in some regards: the placement of large and small villages or camps near productive reefs and protected bays is typical of archaeological sites in the Aleutian Islands.

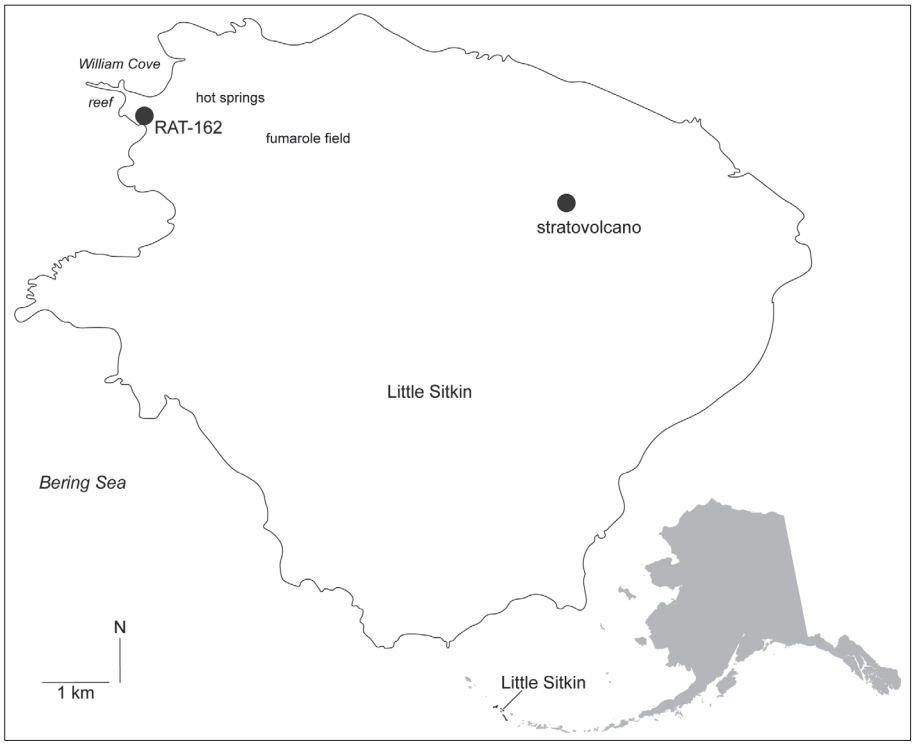

Figure 1. Little Sitkin and key locations in text.

Less typical is the site's presence on an active volcano. RAT-00162 is on Little Sitkin, a dangerously active stratovolcano with several calderas and fumarolic areas and hot springs concentrated on the west side of the island (Global Volcanism Program 2012; Snyder 1959:fig. 1), where RAT-00162 is located. Little Sitkin looks like the frighteningly active volcano it is, with dark ash visible on the multiple smoking lava cones in view from RAT-00162. Eruption records verify two historic eruptions in AD 1766 and AD 1828

(Global Volcanism Program 2012). The more recent eruption occurred on the west flank and certainly threatened the RAT-00162 location. Weekly reports of activity in the 2010s demonstrate fluctuating seismic activity ranging in scale from active earthquake swarms to elevated levels of seismic activity to low-level rumbling and gas venting only (Global Volcanism Program 2012).

A recent analysis of site locations in the Rat Islands demonstrates that Qaŷun occupations tend to be on the nonvolcanic islands or far to the south on islands with active volcanos like Kiska Island (Fitzhugh et al. 2019). In that analysis, wind direction and distance, both of which can offer protection from volcanic gasses and effluvia, were factors in site location decisions. Contrary to the dominant settlement pattern identified in that study, RAT-00162 is in a stable fumarolic area, directly on top of a smoking sulfur deposit, and a westerly 5 km downslope from an active volcano (Fig. 1; Snyder 1959). The atmosphere on the peninsula was dense with smoke and gases during the site survey, and the sulfur deposit appeared to be burning. This site location is unstable and unsafe for long-term occupation, and predictable only in the sense that occupants must have known they were in peril.

The sulfur deposit is exposed on the bluff profile about 1 m below the ground surface, directly below the vegetated surface level. This may be typical for Aleutian Islands sulfur deposits, as similar near-surface deposits (less than 1 m below the surface) were identified in the eastern and central Aleutian Islands more than 100 years ago (Maddren 1919), and Snyder (1959) described other sulfur deposits on the upper south flank of the Little Sitkin cone. The RAT-00162 sulfur deposit is fully exposed as a sheet layer on eroding remnants of the bluff face (Fig. 2).

FEATURES

The site spans 350 m of the bluff from the northwest to southeast. All of the features are within 50 m of the bluff edge, and several have been truncated by active erosion (Fig. 2; Table 1). There are 22 numbered depression features and depression feature clusters, which range in shape and size from small round features to larger rectangular, multifeature complexes. Nine of the features (F1–F9, upper left on Fig. 2) are on a low (< 2 m) 55 x 25 m mound of disturbance vegetation, much like a small-scale traditional occupation midden mound. The rest are in a line along the bluff edge.

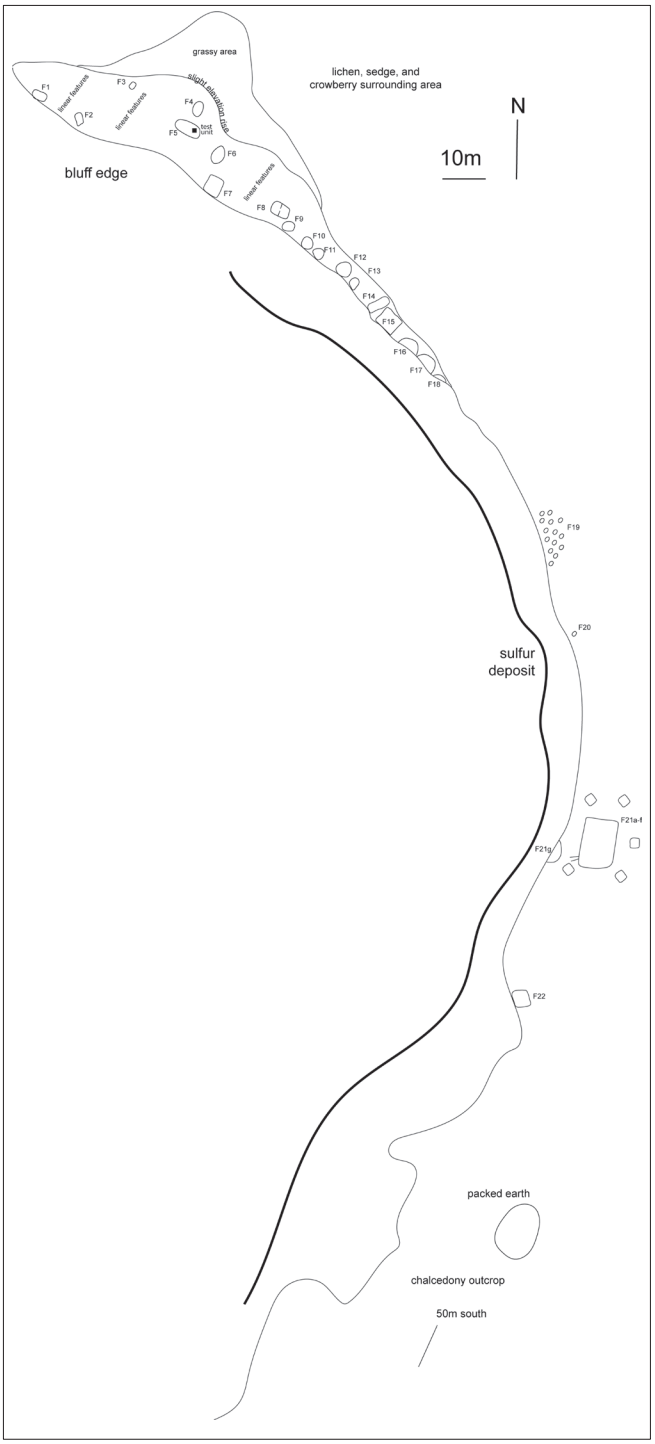

Figure 2. RAT-00162 site landscape, features, and sulfur deposit.

The site features are notably diverse in size and shape compared to traditional village mounds (see, for example, Funk 2011). Features 1–9 (Table 1; Fig. 2), which are depressions in the raised mound area, range from very small, at 1 x 1.5 m, to small, at 4 x 6 m (Corbett et al. 2001; Veltre

Table 1. RAT-00162 feature attributes.

Feature or feature cluster	Size (m)	Depth (m)	Shape
1	1.9 x 1	0.7	rectangular
2	1 x 1.5	0.7	rectangular
3	1.5 x 1.5	0.4	round
4	1.6 x 1.1	0.5	unclear
5*	6 x 3.8	0.6	rectangular
6	4 x 2.3	0.7	unclear
7	4 (truncated) x 4	0.7	rectangular
8	4 x 3.5	1.5	rectangular
9	2.5 x 2.5	0.8	round
10	2.8 x 2.5	0.8	round
11	2.5 x 2.5	0.7	oval
12	4 x 3.5	0.8	round
13	2 x 2	0.8	round
14	5.5 x 2.1	1	rectangular
15	3.5 x 2.5	1	rectangular
16	3.5 (truncated) x 2	0.8	oval
17	3.5 (truncated) x 2	0.8	oval
18	1.5 (truncated) x 1.5	0.5	oval
19	0.8 x .6	0.6	round
20	0.9 x .6	0.6	round
21a	6.5 x 4	1.5	rectangular
21b	1 x 1	1	square
21c	1 x 1	1	square
21d	1 x 1	1	square
21e	1 x 1	1	square
21f	1 x 1	1	square
21g	2 x 1.5 (truncated)	0.7	oval
22	2 x 1.8	1	square

*Feature 5 was tested.

and McCartney 1988). Veltre and McCartney (1988) point out that features of this size and round shape are common across the archipelago, and all of the features present at RAT-00162 are on the low end of the size distribution of 1 m^2 to 260 m^2 for the region. The smallest depression features served a variety of functions in the past, including storage or shelter in the form of small, roofed, semisubterranean constructions (Veltre and McCartney 1988). Here, some of these may have been sulfur mining pits. The somewhat larger but still small features could have served as small semisubterranean family dwellings or, more likely, specialized work crew dwellings, which would not be expected to include the typical extended household and associated multiseason furniture (Corbett et al. 2001).

Feature 8 is different from the others on the mound (Fig. 2). Like Feature 9 at RAT-00081 on nearby Hawadax Island, Feature 8 is a roughly rectangular feature with high exterior berms and an interior berm bisecting the shorter span of the feature (Funk 2011; USBIA 1992). A gap in the interior berm is suggestive of a pass-through or doorway. These architectural characteristics are atypical of traditional Unangam houses. They are constructed with sod walls rather than excavated, and they appear during the early Russian occupation of the region in the late AD 1700s and early AD 1800s (Veltre and McCartney 1988). The topmost and most recent levels of the similarly bisected Feature 9 in RAT-00081 included trade beads and dated to the AD mid-1700s (Funk 2011), and Veltre and McCartney (1988) confidently link this shape to the colonial time period.

Several linear features are clustered among the round, oval, and rectangular features on the mound area of the site (Fig. 2). The linear features range in size from 1 to 2 m long and are approximately 50 cm wide and 75 cm deep. The dense site vegetation prevented precision mapping of the linear features during our abbreviated time on the site. Occasionally linear features form natural drainage gullies near the edge of eroding sites. When this occurs, they are oriented toward the terrace or bluff edge, and usually extend to the edge with no clear ending. The linear features on the mound have distinct ends and are not truncated by the bluff edge. These may be sulfur extraction areas, linear diggings to access the pure sulfur present just below the surface vegetation and shallow peat levels.

Features 10–18 extend across 45 m of the bluff edge southeast of the low mound area (Fig. 2). These features range from 2.5 m to 4 m in length and width; like Features 1–9, they are small but large enough for occupation. Three are truncated by bluff-edge erosion (Features 16, 17, and 18), and it is possible that others were present beyond Feature 18 but are now gone. We recovered a chalcedony scraper from the eroded edge of Feature 16 (UA2014-78-8), indicating that this area of the site was occupied while traditional technologies were in use.

Beyond the truncated depressions, which end at Feature 18, we identified 15 small, roughly circular pits in a cluster (Feature 19 cluster and Feature 20; Fig. 2, center). Each pit is less than 1 m by 60 cm wide and about 60 cm deep. We hypothesize that these are sulfur extraction pits, because they are very small, steeply deep, and placed directly above the sulfur deposit. The linear features described above are longer versions of these small, circular pits.

Features 21a through 21f are grouped in a clearly non-traditional orientation (Figs. 2 and 3); instead, they are similar to the rectangular features described by Veltre and McCartney (1988) as constructed during the colonial period. Feature 21a is a large, 6.5 x 4 m steeply bermed depression about 1.5 m deep. It is strongly rectangular (Fig. 2). Smaller square and steeply bermed depressions (1 x 1 m and 1 m deep) are located surrounding Features 21a. Two traditionally shaped features are nearby, closer to the bluff edge (Feature 21g, which is truncated, and Feature 22).

We mapped an 18 x 13 m tamped earth oval 100 m south of the Feature 21 cluster. The purpose and origin of the tamped area remain unknown, but it was unique in our experience in the western Aleutians. The slope approximately 50 m south of the tamped earth circle includes chalcedony-bearing outcrops.

TEST EXCAVATION

We placed a 30 x 30 cm by 45 cm deep test unit in Feature 5, a well-defined depression feature on the low mound. The test excavation was troweled and followed stratigraphic levels. Excavated materials were not screened, but all observed materials were collected. The test unit revealed clear occupational stratigraphy. Deposits included lithic flakes, lithic tool fragments, charcoal, and extremely poorly preserved faunal remains (Table 2). Cultural deposits appeared to end at 45 cm below the surface (Figs. 4 and 5).

A charcoal sample (UA2014-78-3) from Level 4, 28 cm below the surface, was subjected to AMS dating. The sample at two sigma variation has a 100 percent probability of originating at cal 551–654 BP (Calib 7.0.4; Stuiver et al. 2015; UCIAMS 151547: 615 ± 25 RCYBP wood charcoal $D^{14}C$ = –73.6 ± 2.4). All levels included flakes, with one completed projectile point in Level 3. The soils range from sandy to silty to greasy loam. The sandy loam includes volcanic ash, particularly notable in the lighter fine sandy loam of Level 3, clearly visible in Fig. 5. Occupation was sporadic, as indicated by a series of greasy black levels caused by periods of higher-intensity activity in the feature. Occupation was also episodic, with gaps in use sufficiently long to allow soil and ash deposition between uses.

Figure 3. RAT-00162 Feature 21a, looking south. The smoking sulfur is visible on the slope behind the person on the right. The chalcedony outcropping is visible on the rearmost landscape. Photo by B. Hoffman, 2014.

Table 2. Materials catalog for the RAT-00162 test unit.

Catalog number	Object	Material	Material type	Count	Field tag
UA2014-078-0001	Charcoal	Charcoal	Carbon sample	1	470538
UA2014-078-0002	Charcoal	Charcoal	Carbon sample	1	470541
UA2014-078-0003	Charcoal	Charcoal	Carbon sample	1	470544
UA2014-078-0004	Soil	Soil sample	Soil	2	470546
UA2014-078-0005	Faunal	Animal	Bird bone	2	470172
UA2014-078-0006	Patterned hafted biface	Lithic	Basalt	1	470540
UA2014-078-0007	Retouched slab	Lithic	Basalt	1	470543
UA2014-078-0010	Waste flake	Lithic	Basalt	1	470536
UA2014-078-0011	Waste flake	Lithic	Basalt	2	470537
UA2014-078-0012	Waste flake	Lithic	Basalt	3	470542
UA2014-078-0014	Waste flake	Lithic	Basalt	25	470548
UA2014-078-0015	Bipolar core/tool	Lithic	Basalt	1	470548
UA2014-078-0016	Waste flake	Lithic	Basalt	10	470539
UA2014-078-0017	Waste flake	Lithic	Basalt	5	470545
UA2014-078-0018	Biface fragment	Lithic	Basalt	1	470545
UA2014-078-0019	Biface fragment	Lithic	Basalt	1	470545

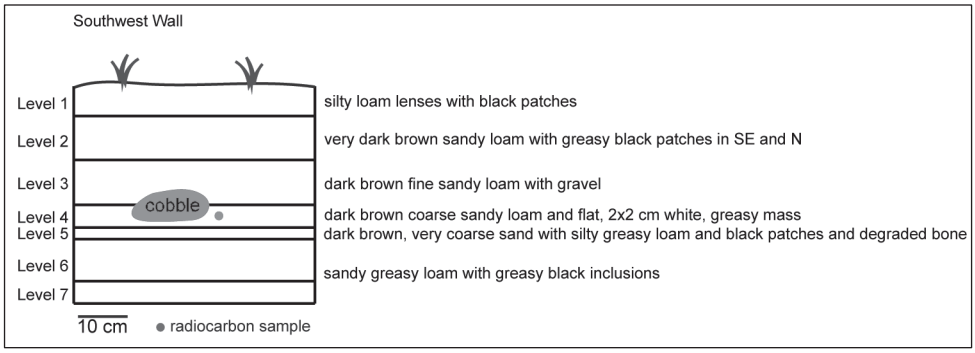

Figure 4. Southwest wall profile of test unit.

Figure 5. Northwest wall profile of test excavation. Note the lighter-colored potential tephra deposit. Photo by C. Funk, 2014.

DISCUSSION

SULFUR IN UNANGAM HERITAGE AND IN RUSSIAN COLONIAL CONTEXTS

RAT-00162 is located on a frankly dangerous volcanic island, on an unstable landform, and above noxiously smoking but easily accessible elemental sulfur. It stretches credulity to believe that the location was occupied without consideration of the risks and rewards. The rich sulfur deposit would have been a valuable mineral resource.

We can speculate that sulfur served similar diverse purposes as described above in ancestral Unangax̂ activities. The most important documented use was as a fire starter (Kul'kov [1762] in Dmytryshyn et al. 1988:227; Langsdorff 1993:3; Ocheridin [1765] in Coxe 1780). European explorers documented that people obtained rock-sized pieces of sulfur in the mountains, scraped them onto dry grass and bird down, and struck sparks from quartz (Kul'kov [1762] in Dmytryshyn et al. 1988:227; Lisenkov [1761] in Black 1984; Merck 1980:77; Ponomarev [1759] in Andreev 1948a:72; Sarychev 1806:72; Sauer 1802:124). Hanging on the wall of each house was a fire-starting box that held flints, sulfur, and dried grass (Sauer 1802:203). We can also document that it was used in weapons:

> In the evening, after reaching Ilaaĝanaax̂'s settlement, they filled two baidarka frames with sulfur balls and went toward Ilaaĝanaax̂'s house and were about to light the sulfur balls in one of the baidarka frames. Ilaaĝanaax̂ came out carrying his wife on his back, and when she asked her brother not to touch her, he told her to get away from him. And having lighted the [frame with] sulfur balls they let it into the house, but the people in the house extinguished it. And they lifted the other [frame with] sulfur balls and let it in, and the people in the house tried to extinguish it but were unable to and so died from it, so the story goes. (Bergsland and Dirks 1990:673 Narrative 85, Attuan)

Narratives 68 and 73 also directly mention the use of sulfur as weaponry, and two other tales indirectly reference it (Bergsland and Dirks 1990), making sulfur a not-uncommon topic in the narratives.

Qax̂un used this location from at least 600 years ago, three centuries prior to Russian arrival in the Aleutian Islands in the AD mid-1740s. Several traditional features present in a cluster on a low occupation mound are entirely typical for coastal sites throughout the region. However, other site features provide evidence that the location was not simply residential but was also excavated. The location was also used during the Russian era. The similarity of Feature 8 to other colonial-era features in the Rat Islands and the clearly non-Unangam-style Feature 21 feature cluster likely result from combined Russian-Qax̂un activity (Feature 8) and possibly entirely Russian activity (Feature 21).

Sulfur was in high demand as firearms became more prevalent in Europe (Mehler 2015), and Russian government instructions to merchants and government explorers required attention to potential mineral resources in newly discovered lands. As a result, Russian commercial and government reports occasionally mentioned sulfur deposits. The Cossack Vasiutinsky mentioned sulfur extraction by ancestors of Unangax̂ from Kanaga volcano in the early 1760s (Andreev 1948b:25; Coxe 1780:85). The merchant Kul'kov mentioned sulfur from Unalaska in 1762 (Dmytryshyn et al. 1988:227). Government expeditions in the 1760s, 1790s, and early 1800s all mention Unangax̂ use of sulfur in Unalaska (Glushankov 1973; Langsdorff 1993:145; Sarychev 1806:57, 60). Despite an interest in mineral resources, mining in Russian America was neglected and undeveloped, and no commercial mining of sulfur is recorded (Black 2004; Dilliplane 1990; Fedorova 1973; Khlebnikov 1994).

The region-wide distribution of sulfur and cross-cultural interest in acquiring it may allow for opportunities in examining trade and travel through the archipelago. Pure elemental sulfur cannot be sourced. However, sulfur containing mineral impurities theoretically could be sourced to particular deposits, and ownership and distribution networks could be identified. Pan-Aleutian sulfur sources remain unmapped and unanalyzed, and such archaeological finds are rare, making such studies infeasible at this time.

SULFUR PROCESSING FEATURES AND TOOLS

Medieval solfatara sulfur mining and processing in Iceland, another subarctic context, offers useful insight for interpreting several of the site features and for opportunities for future investigation (see Mehler 2015). Sulfur itself does not preserve well in archaeological contexts (Mehler 2015), so identifying areas of exploitation must rely on identifying the tools and features related to extraction and processing.

Sulfur processing and refining in Iceland included washing, drying, and melting phases to increase purity. Elemental sulfur processing in medieval Iceland is de-

scribed as occurring in a multifeature context, which includes a turf-built washing and melting works (approx. 4 x 6 m, cf. Feature 21a), storage houses for raw and unrefined sulfur, and living areas (Mehler 2015:198). Features 21a–f are constructed in a uniquely non-Unangam style, are evocatively the same size as the Icelandic sulfur works, and include distinctly separate but clearly associated subfeatures. These features should be tested for evidence of sulfur refining tools and slag, and time period of use, although their temporal placement in the colonial era is not in question, based on feature shape and configuration (Veltre and McCartney 1988).

The refining process would have required a water washing apparatus and/or an abundance of oil for the melting part of the process (see Mehler 2015 for a complete description of medieval Icelandic sulfur refining processes). If sulfur is water-washed, a water source and a drying phase are absolutely required. Springs east of the site would have provided a clean water source. Drying anything in the Aleutian Islands is uncertain at best, but this does pose an interesting possibility for the large stamped area on the south end of the site. Could this have been a sulfur drying platform? The use of oil in the final (but not always necessary) refinement phase would have required an abundance of fish oil or other imported oil. This offers opportunities for testing for fish processing or trade materials at the site.

Sulfur processing tasks in medieval Iceland required only two to six people, whether washing or melting (Mehler 2015). We assume that sulfur mining and processing in the Aleutian Islands would have been analogous or even smaller in scale. This means that associated domestic spaces could be quite small, with a limited number of families present or small groups of special task collaborators camping together to mine and process the sulfur. If it is a Russian-era sulfur processing feature, Features 21a–g would not have demanded a large mining and processing crew to be a fairly productive endeavor. Perhaps the Russian-era crew lived in Feature 8 on the mound.

We know that Qax̂un were present prior to the Russian colonial era features and sulfur extraction. The traditional features at RAT-00162 should be tested for traditional Unangam sulfur processing tools, including heating or simple water-washing process tools (as in Mehler 2015). If they used sulfur without further refinement, we expect that digging tools and stratigraphic evidence for mining would be present.

CONCLUSION

We interpret RAT-00162 as a long-term sulfur exploitation site first used by Qax̂un and then by Russian colonizers. We suggest that both groups exploited the sulfur for personal use and trade opportunities. Regrettably, the site was eroding rapidly in June 2014, with many features truncated by the active bluff face. We visited this site on our final afternoon in the field, and we had just four hours to map and test it. Two days after we left the Rat Islands, an Mw 7.9 earthquake struck the area, the epicenter just 39 km southeast of Little Sitkin Island. Such potentially damaging events are common in the region. This unique site should be tested further before it is gone.

The probability that other sulfur mining occupations existed on Little Sitkin's stable fulmarolic fields and other shallow sulfur deposits in the archipelago is high. Little Sitkin Island should be more thoroughly investigated, particularly in the surrounding fulmarolic fields, to learn more about this little-defined aspect of ancestral Unangam knowledge. Other known sulfur deposits in the region also may prove to have been exploited by Unangax̂ in the past.

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