Geothermics 57 (2015) 127–144

Contents lists available at ScienceDirect

Geothermics

journal homepage: www.elsevier.com/locate/geothermics

Exploration of the Hot Springs Bay Valley (HSBV) geothermal resource area, Akutan, Alaska

Pete Stelling[1,*], Nicholas H. Hinz[2], Amanda Kolker[3], Mary Ohren[4]

[1] Western Washington University, 516 High St., Bellingham, WA 98225-9080, USA
[2] Nevada Bureau of Mines and Geology, University of Nevada, Reno, NV 89557, USA
[3] AK Geothermal, 10, Chemin de Pougnan, 33670 St. Genes de Lombaud, France
[4] Geothermal Resource Group Inc., 77530 Enfield Ln Bldg E, Palm Desert, CA 92211, USA

ARTICLE INFO

Article history:
Received 20 November 2014
Accepted 6 May 2015
Available online 4 July 2015

Keywords:
Akutan
Alaska
Geothermal
Alteration
Erosion
Geothermometry
Magnetotellurics
Conceptual model

ABSTRACT

The Hot Springs Bay Valley (HSBV) geothermal resource area on Akutan Island, Alaska, has been explored since 2009. Geological, geochemical, geophysical surveys and the drilling of two thermal gradient wells suggest a mature neutral-chloride reservoir between 240 and 300 °C, with outflow temperatures ~180 °C. A network of regional and local structures control near-surface permeability. Alteration, mineralization and geophysical patterns, including high-temperature hydrothermal minerals at unexpectedly shallow depths of formation, indicate a poorly to moderately developed clay cap, likely the result of erosion of the upper portion of an older, well developed system.

1. Introduction

The northern rim of the Pacific Ocean contains a wide variety of resources that have global economic impact. The North Pacific and Bering Sea is host to one of the world's most productive fishing grounds and fish processing facilities, and the North Pacific air corridor supports the greatest wealth of cargo transportation in the world (Fierstein and Hildreth, 2000). However, due to a low population density, the infrastructure in the Aleutians does not reflect the important role the rich fishing grounds and cargo hub this region provides to the global economy. In particular, the energy infrastructure is almost exclusively based on diesel oil barged in from Seattle and other ports for electricity, heating and cooling (Gray, 2007). The added expense of importation results in high electricity prices and a potentially vulnerable energy supply chain (Kolker and Mann, 2009).

One community in the Aleutian Islands that is attempting to expand its power infrastructure is the City of Akutan (COA), home to 120 year-round residents and the municipal base for the flagship fish processing facility for Trident Seafoods, the second largest such facility in the world. The combined electrical peak demand of the city and processing facility is ~7–8 MWe, a need currently met by the annual burning of 4.3 million gallons of diesel fuel (in 2008; Kolker and Mann, 2009). As a result, base cost of power in the City of Akutan is ~$0.323/kW h (in 2008). The COA is striving to diversify its energy portfolio and reduce the cost of electricity and heating by developing a nearby geothermal resource in Hot Springs Bay Valley (HSBV). Successful development of the HSBV resource will help to stabilize the energy supply on Akutan Island and help to promote continued infrastructure development throughout the North Pacific.

Akutan Island sits in the central portion of the Aleutian volcanic arc (Fig. 1), one of the most volcanically and tectonically active subduction zones in the world (Simkin and Siebert, 1994). The most prominent feature on the island is Akutan Volcano (Fig. 1), the primary locus of volcanic activity on the island for at least the last 0.5 million years (Miller et al., 1998; Richter et al., 1998). The remainder of the island is composed of glacially scoured remnants of Pliocene and Pleistocene (~3.3–1.4 Ma; Romick, 1982; Romick et al., 1990; Richter et al., 1998) plutonism, volcanism and mass wasting deposits that form the basement rocks of the island (Finch, 1935; Coats, 1950; Byers and Barth, 1953). These older deposits are composed of gently dipping basaltic to dacitic lavas, ash falls and debris flows that have been locally intruded by younger (0.6 Ma; Richter et al., 1998) mafic to andesitic dikes and

* Corresponding author. Tel.: +1 360 650 4095; fax: +1 360 650 7302.
E-mail address: pete.stelling@wwu.edu (P. Stelling).

http://dx.doi.org/10.1016/j.geothermics.2015.05.002
0375-6505/

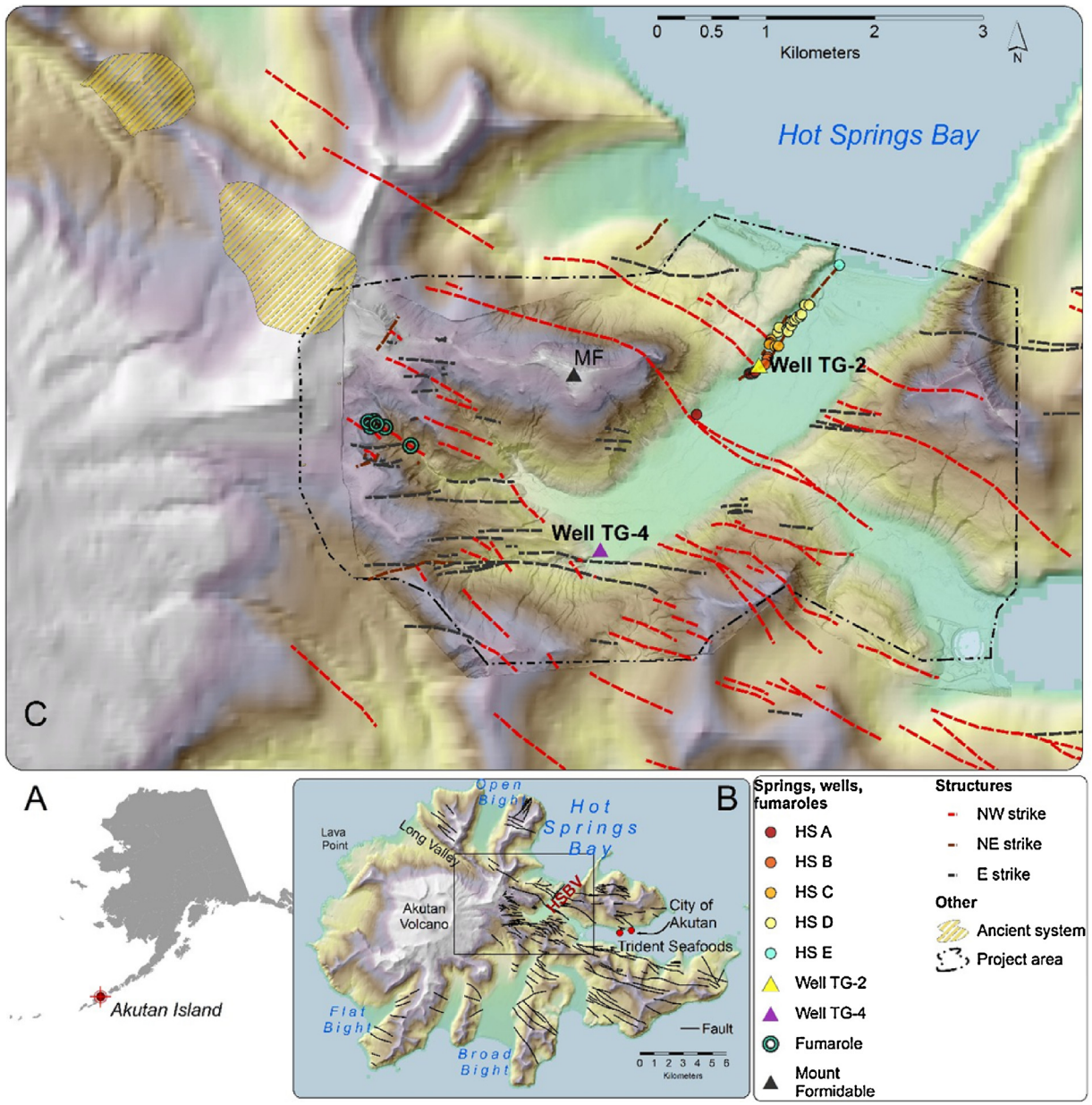

Fig. 1. Location and features of Akutan Island. (A) Location of Akutan within Alaska. (B) Akutan Island, with the City of Akutan and Trident Seafoods fish processing facility, Hot Springs Bay Valley (HSBV), Long Valley and Lava Point identified as well as island-wide structures (black lines = fault traces). Black rectangle indicates extent of HSBV focus map (C). (C) Geothermal surface features and structures of HSBV (see legend). MF refers to Mount Formidable; structures are symbolized by dominant strike orientation.

small plutons. The most recent major glaciation on Akutan Island retreated ~10,000 years ago (Waythomas, 1999), at which time it stripped surficial deposits from the majority of the island. Since glacial retreat, valley floors and areas proximal to Akutan volcano have been covered in volcaniclastics and erosional deposits (Finch, 1935; Coats, 1950; Byers and Barth, 1953). Richter et al. (1998) observed island-wide fracture networks trending NW/SE across both ancestral and modern Akutan units. Part of this fault system was re-activated in March 1996, when a swarm of >3000 earthquakes (M_{max} = 5.1) occurred over a 48 h period (Lu et al., 2000). Subsequent field studies confirmed that a set of NW/SE trending ground cracks were formed during this seismic event on the NW flank of the modern volcano extending from the summit of Akutan Volcano to Lava Point, a satellite vent on the NW coast of the island (Fig. 1). This deformation was interpreted as an injection of a shallow, east–west trending, north-dipping dike plus inflation of a deep magma body beneath the volcano (Lu et al., 2000). Seismic velocity tomography studies reveal a low velocity zone at ~7.5 km depth beneath the eastern flank of the volcano (Syracuse et al., 2015).

Akutan Island hosts two active hydrothermal systems, one located within the intracaldera cone at the summit of Akutan Volcano and the other ~3 km northeast of the volcano summit in Hot Springs Bay Valley (HSBV; Fig. 1). The summit system consists of at least three fumarole vents and a small number of hot springs, and appears to be an acid sulfate system associated with the active magma chamber (Finch, 1935; Romick et al., 1990; Miller et al., 1998; Kolker et al., 2012). The largest and the most accessible geothermal prospect area is HSBV, which occupies portions of two linear, glacially carved valleys (Fig. 1) in the Pliocene-Pleistocene deposits of ancestral Akutan Volcano (Finch, 1935; Motyka and Nye, 1988; Romick, 1990; Motyka et al., 1993; Richter et al., 1998, Waythomas, 1999). Bergfeld et al. (2014) demonstrates that the heat flow from the lower HSBV chain of hot springs has increased