STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

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Report of Investigations 88-18

# ALASKA GEOTHERMAL BIBLIOGRAPHY

By

S.A. Liss, R.J. Motyka, and C.J. Nye

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STATE OF ALASKA
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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# ALASKA GEOTHERMAL BIBLIOGRAPHY

Compiled by
S.A. Liss,[1] R.J. Motyka,[2] and C.J. Nye[3]

## INTRODUCTION

The complete hard-copy listing of the Alaska geothermal bibliography is a 300-page document. Presented here are a list of contents, example formats for Sections I, II, and III, tables of codes and abbreviations, figures showing geothermal spring locations, and appendixes from the original document.

The Alaska geothermal bibliography is presented in five sections. Section I is a standard format alphabetical bibliography which lists all publications, currently through 1986, that discuss any facet of geothermal energy in Alaska. In addition, selected publications about geology, geophysics, hydrology, volcanology, or the like, which discuss areas where geothermal resources are located, are included, though the geothermal resource itself may not be mentioned. The bibliography contains 870 entries, and is constantly being updated.

Section II is an alphabetical listing by author regardless of where the author's name appears in the citation. Each entry gives the first author, year of publication, abbreviated title, and codes for subject category. The subject codes are listed in order of emphasis in the article. Table 1 lists the abbreviations most commonly used in the shortened titles. Table 2 provides an index of subject codes.

Section III is a listing of references for each of the 123 geothermal sites in alphabetical order. Each main entry gives the site name and identification number. Figure 1 shows areas covered by figures 2 through 11, on which locations of the geothermal sites are shown. Table 3 provides the identification key. For consistency, geothermal site ID numbers are the same as those used on the NOAA map of Geothermal Resources of Alaska, scale 1:2,500,000 (Motyka and others, 1983). The map is available from the Alaska Division of Geological and Geophysical Surveys. Under each geothermal site is a listing of authors, abbreviated titles, and subject codes. Several sites are included which do not appear on the NOAA map. They fall into one of three categories: 1) sites which have had geothermal manifestations in recent past--for example, Bogoslof; 2) sites which are good candidates for the occurrence of a geothermal resource due to presence of recent volcanism--for example, Edgecumbe; 3) sites which have been identified since 1983, the map's publication date--for example, Upper Noatak. Early references sometimes used different names for the same site, so table 4 is included to give the known aliases.

Section IV is a supplemental listing of references by geographical region. Figure 1 shows the boundaries of the regions used in this section and figures 2 through 11 are enlargements of each region with the geothermal sites indicated. Under each main entry is again, a listing of authors, abbreviated titles, and subject codes. References in this section generally cover a large geographic

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[3] Geophysical Institute, University of Alaska, Fairbanks, Alaska 99775,

area and are not usually listed in section III under any specific geothermal site,

Section V is a listing of references by subject. Main entries are identical to those in table 2. Under each subject is, as usual, a listing of authors, abbreviated titles, and subject codes. The subject heading 'Geothermal' contains every reference which specifically mentions a geothermal site, regardless of context. Actual geothermal studies are marked ‘R' in the subject code.

All or any part of this bibliography is available on 5 1/4 or 3 1/2 inch computer diskettes, formatted in the MS-DOS operating system. It is available as a set of four .DBF files for use with DBASE3+. These files can be easily used with Alaska Division of Geological and Geophysical Surveys Public-data File 88-13, 'A geologically orientated bibliography program.' This is the program which was used to create all the listings in the bibliography. Microsoft Word was used to add the appendices and create the final hard copy. About 850K is needed for these four files, the largest of which is about 500K. This bibliography is constantly being updated, so when you request the computer files, you receive the current up-to-date version. Hard copies of this document can be obtained at $0.10 per page.

# ALASKA GEOTHERMAL BIBLIOGRAPHY

## SECTION I

## STANDARD BIBLIOGRAPHICAL LISTING

(Example Format)

Ach, J., and DeLong, S.E., 1980, Magmatic evolution of Little Sitkin and Semisopochnoi volcanoes, Alaska [abs.]: EOS, v. 61, p. 1140.

Adams, D.D., 1983, Geology of the northern contact area of Arrigetch Peaks pluton, Brooks Range, Alaska: Fairbanks, University of Alaska, unpublished M.S. thesis, 86 p.

Adams, D.D., 1984, Geology of the northern contact area of the Arrigetch Peaks pluton, Brooks Range, Alaska [abs.]: Geological Society of America, Cordilleran Section, Abstracts with Programs, v. 16, no. 5, p. 265.

Alaska Geological Consultants, 1975, ERDA Geothermal energy program, Drum Thermal Springs Area: Report of Oct. 1975 for AHTNA Native Regional Corporation.

Allely, R.D., 1986, Interpretation of seismic-refraction profiles at the proposed site for a geothermal power plant, in Updike, R.G., ed., Engineering geology technical feasibility study, Makushin geothermal power project Unalaska, Alaska: Fairbanks, Alaska Division of Geological & Geophysical Surveys, Public-data File 86-60, p. B15-B20.

Allen, E.T., and Zies, E.G., 1923, A chemical study of the fumaroles of the Katmai region: National Geographic Society, Contributed Technical Papers, Katmai Series, v. 2, p. 75-155.

Andreasen, G.E., Dempsen, W.J., Henderson, J.R., and Gilbert, F.P., 1958, Aeromagnetic map of the Copper River Basin, Alaska: U.S. Geological Survey, Geophysical Investigations Map GP-156, scale 1:125,000.

Andreasen, G.E., Grantz, A., Zietz, I., and Barnes, D.F., 1964, Geologic interpretation of magnetic and gravity data in the Copper River basin, Alaska: U.S. Geological Survey Professional Paper 316-H, p. 135-153.

Anma, K., 1971, An aeromagnetic survey in the Valley of Ten Thousand Smokes, Alaska: Fairbanks, University of Alaska, unpublished M.S. thesis, 97 p.

Anonymous, 1953, Activity of Trident Volcano: Volcano Letters, no. 520, p. 5-6.

Anonymous, 1953, Eruption of Trident Volcano, Alaska: Volcano Letters, no. 519, p. 7.

Anonymous, 1975, Alaska Regional Profiles, 1975, v. 3, Southwest Region, sponsored by Alaska with the Joint Federal-State Land Use Planning Commission for Alaska: Wheelright Lithography Co., Salt Lake City, 313 p.

Anonymous, 1982, Gates of the Arctic, Reed River Hot Springs: National Park Service, Denver Service Center, Branch of Special Programs, Special Report, 19 p.

Arce, G.N., 1983, Volcanic hazards from Makushin Volcano, Northern Unalaska Island, Alaska: Fairbanks, University of Alaska, unpublished M.S. thesis, 142 p.

Arce, G.N., and Economides, M.J., 1982, Analysis of volcanic hazards from Makushin Volcano, Unalaska Island: Proceedings IV New Zealand Geothermal Workshop, p. 93-99.

Bader, J.W., 1984, Geologic map of the Demarcation Point, Mount Michelson, Flaxman Island, and Barter Island quadrangles, Alaska: U.S. Geological Survey Open-file Report 84-569, scale 1:250,000.

Bader, J.W., and Bird, K.J., 1986, Geologic map of Demarcation Point, Mt. Michelson, Flaxman Island, and Barter Island quadrangles, N.E. Alaska, Latitudes 69 deg to 70 deg 45 min N, Longitudes 141 - 147 deg W: U.S. Geological Survey Miscellaneous Investigations Map 1-1791, 1 pl., scale 1:250,000.

Baker, D.R., and Eggler, D.H., 1983, Fractionation paths of Atka (Aleutians) high alumina basalt: Constraints from phase relations: Journal of Volcanology and Geothermal Research, v. 18, p. 387-404.

Baker, R.O., Lebida, R.C., Pyle, W.D., and Britch, R.P., 1977, An investigation of selected Alaska geothermal springs sources as possible salmon hatchery sites: National Technical Information Service IDO/1624-1, 173 p.

Barnes, Ivan, and McCoy, G.A., 1979, Possible role of mantle-derived CO2 in causing two "phreatic" explosions in Alaska: Geology, v. 7, p. 434-435.

Barnes, Ivan, and Miller, T.P., 1974, Geothermal studies in Alaska [abs.]: Geological Society of America, Abstracts with Programs, v. 6, no. 7, p. 645-646.

Barnwell, W.W., and Pearson, K.S., 1984, Alaska's Resource Inventory: Fairbanks, Alaska Division of Geological and Geophysical Surveys, Special Report 36, 59 p.

# ALASKA GEOTHERMAL BIBLIOGRAPHY

## SECTION II

## AUTHOR LISTING

(Example Format)

(see Table 1 - Abbreviations used in short references)
(see Table 2 - Codes used in short references)

| AUTHOR | TOPIC |
|---|---|
| Abramson, B.S. | |
| Gassaway & Abramson 1977 Map & table thermal springs cntr | Ak R,Fs |
| Ach, J. | |
| Ach & DeLong 1980 Magma evo L. Sitkin & Semisopochnoi [abs.] | PG |
| Adams, D.D. | |
| Adams 1983 Geol northern Arrigetch pluton (thesis) | Gr |
| Adams 1984 Geol northern Arrigetch Peaks pluton [abs.] | Gr |
| Dillon & others 1983 Geol map Melozitna A-4 Quad | Gr |
| Adler, P. | |
| Dillon & others 1983 Geol map Melozitna A-4 Quad | Gr |
| Alaska Geological Consultants | |
| AGS 1975 Drum thermal springs area | DP |
| Albanese, M.D. | |
| Turner & others 1980 Geothermal resources Alaska | R,Fs |
| Allaway, W.H. Jr. | |
| Detterman & others 1983 Geol map Ugashik-Bristol Bay-Karluk Q | Gr |
| Allely, R.D. | |
| Allely 1986 Seismic refraction Makushin | Ps |
| Motyka & others 1985 Geol geoc geophys Akutan | *,Gs,Fs,Ps,RM,Ff,DP |
| Allen, E.T. | |
| Allen & Zies 1923 Chem study fumaroles Katmai region | Ff |
| Anderson, A.T. | |
| Woodruff & Anderson 1980 Arrested magma mixing Pavlov | PG |
| Andreasen, G.E. | |
| Andreasen & others 1958 Aeromag Copper River basin | Pr |
| Andreasen & others 1964 Geol inter mag & grav Copper Rvr basn | Pr |
| Anma, K. | |
| Anma 1971 Aeromag survey VTTS (thesis) | Pr |
| Stone & others 1971 Magnetic anomalies VTTS [abs.] | Pr |

| AUTHOR | TOPIC |
|---|---|
| **Anonymous** | |
| Anonymous 1953 Activity of Trident | V |
| Anonymous 1953 Eruption of Trident | V |
| Anonymous 1975 Ak regional profiles SW region | C |
| Anonymous 1982 Reed River Hot Springs | Fs |
| **Ansari, J.** | |
| Economides & others 1982 Eng,geol anal geothermal sites | EF,Er |
| **Arce, G.N.** | |
| Arce 1983 Volcanic hazards Makushin Volcano (thesis) | Eg |
| Arce & Economides 1982 Volcanic hazards Makushin Volcano | Eg |
| Economides & Arce 1983 Geothermal in Ak - eng & geol anal | EF,Er |
| Economides & others 1982 Eng,geol anal geothermal sites | EF,Er |
| **Bader, J.W.** | |
| Bader 1984 Geol map eastern N. slope Ak. | Gr |
| Bader & Bird 1986 Geol map NE Alaska | Gr |
| **Baker, A.A.** | |
| Smith & Baker 1924 Cold Bay-Chignik dist | Gr,H |
| **Baker, D.R.** | |
| Baker & Eggler 1983 Atka high alumina basalt | PG |
| **Baker, R.O.** | |
| Baker & others 1977 Geotherm springs-salmon hatchery site | R,DP,Fs |
| **Bakke, A.** | |
| Robinson & others 1986 Geol map Mt. Michelson C-4 Quad | Gr |
| **Bamford, R.W.** | |
| Isselhardt & others 1983 Temp grads Makushin geothermal area | HS |
| **Barnes, D.F.** | |
| Andreasen & others 1964 Geol inter mag & grav Copper Rvr basn | Pr |
| **Barnes, Ivan** | |
| Barnes & McCoy 1979 Mantle-derived CO2 in 2 phreatic expl | Fs,Ff,V |
| Barnes & Miller 1974 Geotherm studies in Alaska [abs.] | R,Fs |
| Miller & Barnes 1974 Geotherm devel Ak [abs.] | DP,Gr,V |

# ALASKA GEOTHERMAL BIBLIOGRAPHY

## SECTION III

## GEOTHERMAL SITE LISTING

(Example Format)

(see Table 1 - Abbreviations used in short references)
(see Table 2 - Codes used in short references)
(see Figures for geothermal site locations)

| GEOTHERMAL SITE | TOPIC |
|---|---|
| *Aciak AA-4* | |
| Berry & others 1980 Thermal spring list U.S. | R |
| Bliss 1983 Ak basic data thermal springs & wells | R,Fs,Fw |
| Coats 1947 Geol N Adak Island | Gr |
| Coats 1952 Magmatic different Adak & Kanaga Islands | PG |
| Coats 1956 Geol N Adak Island | Gr |
| Coats 1956 Recon geol W Aleutian Islands | Gr |
| Conrad & Kay 1984 Inclusions Adak Is-nature of primary magma | PG |
| Fraser & Snyder 1959 Geol S Adak & Kagalaska Islands | Gr |
| Markle 1979 Geotherm Ak site data base & devel status | R,Fs,Gr,C |
| Miller 1973 Distribution & chem analysis thermal springs Ak | R,Fs |
| Motyka 1983 High temp hydrothermal resources Aleut arc | R,Fs,Ff |
| Motyka & others 1983 Geothermal resources of Alaska | R,Fs,Ff,Fw |
| Myers & others 1986 Isot var Adak & Atka volc plumb | V,PG,Gr |
| Peale 1886 Mineral springs of US | H,R |
| Turner & others 1980 Geothermal resources Alaska | R,Fs |
| Waring 1965 Thermal springs US & world - a summary | Fs |
| White & Williams 1975 Assmt geothermal resources US | R,Fs,HS |
| *Akun Strait AA-23* | |
| Berry & others 1980 Thermal spring list U.S. | R |
| Bliss 1983 Ak basic data thermal springs & wells | R,Fs,Fw |
| Byers & Barth 1953 Volc activity Akun & Akutan Islands | V |
| Coats 1956 Recon geol W Aleutian Islands | Gr |
| Miller 1973 Distribution & chem analysis thermal springs Ak | R,Fs |
| Motyka & Moorman 1981 Recon thermal spr Aleutian arc | R,Fs,Ff |
| Motyka & others 1981 Assmt thermal spring Aleutian arc | R,Fs,Ff,Gr |
| Motyka & others 1983 Geothermal resources of Alaska | R,Fs,Ff,Fw |
| Peale 1886 Mineral springs of US | H,R |
| Turner & others 1980 Geothermal resources Alaska | R,Fs |
| Waring 1965 Thermal springs US & world - a summary | Fs |
| *Akutan Volcano AA-21* | |
| Brown 1899 Shishaldin | H |
| Byers & Barth 1948 Geol Akutan Island | Gr |
| Byers & Barth 1953 Volc activity Akun & Akutan Islands | V |
| Davidson 1893 Eruption of Veniaminof | H,V |
| Finch 1935 Akutan volcano | V,H |
| House & others 1981 Seismic gap near Unalaska | Gs |
| Miller & Barnes 1974 Geotherm devel Ak [abs.] | DP,Gr,V |
| Miller & Barnes 1976 Geotherm develop Ak summary | DP,Gr,V |
| Motyka 1982 Fluid geochem Makushin & Akutan geotherm area | Ff,Fs |
| Motyka & others 1983 Geothermal resources of Alaska | R,Fs,Ff,Fw |
| Motyka & others 1985 Geol geoc geophys Akutan | *,Gs,Fs,Ps,RM,Ff,DP |
| Prosser 1912 Volcanic road-building | H,V |
| Reeder 1983 Prelim dating Holo volcanic E Aleut Is [abs.] | V,Gr |
| Romick 1982 Ig petro & geochem N. Akutan Is (thesis) | PG |
| Romick 1983 Ig petro & geochem N. Akutan Is [abs.] | PG |
| Romick 1986 Ig pet and geochem N. Akutan | PG |
| Romick & Swanson 1983 Petro & fract lava Akutan Is [abs.] | PG |
| Smith & Shaw 1979 Igneous related geothermal systems | R,HS |

| | |
|---|---|
| Swanson & Blum 1984 Evol of volc centers Aleutian arc [abs] | V,Gr |
| Wescott & others 1982 Geophys survey Hot Springs Akutan Is | Ps |
| White & Williams 1975 Assmt geothermal resources US | R,Fs,HS |

*Aniakchak AA-34*

| | |
|---|---|
| Berry & others 1980 Thermal spring list U.S. | R |
| Bliss 1983 Ak basic data thermal springs & wells | R,Fs,Fw |
| Detterman & others 1979 Geol map Chignik & Sutwik Is Q | Gr |
| Detterman & others 1981 Geol map Chignik & Sutwik Is Q | Gr |
| Detterman & others 1981 Quat geol map Chignik & Sutwik Is Q | Gr |
| Hansen & others 1981 Mineral potential Ak Penin. | Gr |
| Hubbard 1931 Geol Aniakchak & Veniaminof [abs.] | Gr,H |
| Hubbard 1931 World inside a mountain | V,H |
| Knappen 1926 Geol & min resources Aniakchak | Gr |
| Knappen 1933 Aniakchak & Veniaminof volcanoes [abs.] | Gr,H |
| LeCompte & Steele 1981 Map Landsat Chignik & Sutwik Is Q | Gr |
| Lyle 1973 Geol & mineral evaluation Aniakchak R drainage | Gr |
| Markle 1979 Geotherm Ak site data base & devel status | R,Fs,Gr,C |
| Miller 1978 Airfall pumice Aniakchak | V |
| Miller & Barnes 1974 Geotherm devel Ak [abs.] | DP,Gr,V |
| Miller & Barnes 1976 Geotherm develop Ak summary | DP,Gr,V |
| Miller & Smith 1976 New volcanoes Aleutian arc | V |
| Motyka & others 1981 Assmt thermal spring Aleutian arc | R,Fs,Ff,Gr |
| Motyka & others 1983 Geothermal resources of Alaska | R,Fs,Ff,Fw |
| Reed & others 1983 Data low temp geothermal systems US | HS,R,Fs |
| Smith 1925 Aniakchak Crater | Gr,H |
| Smith & Baker 1924 Cold Bay-Chignik dist | Gr,H |
| Smith & Shaw 1979 Igneous related geothermal systems | R,HS |
| Turner & others 1980 Geothermal resources Alaska | R,Fs |
| White & Williams 1975 Assmt geothermal resources US | R,Fs,HS |

*Arrigetch NC-39*

| | |
|---|---|
| Adams 1983 Geol northern Arrigetch pluton (thesis) | Gr |
| Adams 1984 Geol northern Arrigetch Peaks pluton [abs.] | Gr |
| Berry & others 1980 Thermal spring list U.S. | R |
| Brosge & Pessel 1977 Prelim recon geol map Survey Pass Q | Gr |
| Nelson & Grybeck 1978 Arrigetch Peaks & Igikpak plutons | Gr |

*Augustine SC-11*

| | |
|---|---|
| Barrett 1978 Magnetic model of Augustine Volcano (thesis) | V,Ps |
| Barrett & others 1977 Model of Augustine Volcano [abs.] | V,Ps |
| Beget 1986 Prehistoric tephra at Augustine [abs.] | V,Gs |
| Daley 1986 Petro, geochem & evol magmas Augustine (thesis) | PG |
| Daley & Swanson 1985 Low press fractionation Augustine [abs.] | PG |
| Davidson 1884 Notes volc eruption Augustine | H,V |
| Davies & Kienle 1986 Augustine eruption & advice [abs.] | V,C |
| Decker 1967 Invest at active volcanoes | V |
| Detterman 1968 Volcanic activity Augustine Island | V |

# ALASKA GEOTHERMAL BIBLIOGRAPHY

# TABLES

# AND

# FIGURES

Table 1. Abbreviations used in short references.

| | |
|---|---|
| & | and |
| < | less than |
| = | equal to |
| > | greater than |
| abs | abstract |
| adj | adjacent |
| aeromag | aeromagnetic |
| Ak. | Alaska |
| Aleut | Aleutians |
| alk | alkaline |
| alt, alter | alteration |
| anal | analysis |
| assim | assimilation |
| assmt | assessment |
| Augst | Augustine |
| basn, bsn | basin |
| bdrck | bedrock |
| cald | caldera |
| Can | Canada |
| cent, cntr, C | center, central |
| chmbr | chamber |
| chem | chemical, chemistry |
| Cl | Chlorine |
| classif | classification |
| cmplx | complex |
| comp | composition, compaction |
| cond | condensates |
| conduct | conductivity |
| contr | contribution |
| correl | correlation |
| cr | creek |
| Cret | Cretaceous |
| DSDP | Deep Sea Drilling Project |
| dep, depos | deposit(s), depositional |
| devel | development |
| different | differentiation |
| dist | district |
| E | east, eastern |
| econ | economic |
| elect | electrical |
| elem | element |
| empl | emplacement |
| eng | engineering |
| envir, environ | environment |
| equil | equilibria(ium) |
| erupt | eruption |
| est | especially, estimates |
| eval | evaluation |
| evid | evidence |
| evo, evol | evolve(d), evolution |
| expl | explosions, explosive, explanation, exploration |
| F | Fluorine |

| | |
|---|---|
| feasibil | feasibility |
| fluct | fluctuations |
| form | formation |
| Fr | French |
| fract | fractionation |
| frm | from |
| fum | fumarole |
| geochem | geochemistry, geochemical |
| geochron | geochronology |
| geol | geology |
| geomorph | geomorphology |
| geoph(ys) | geophysics, geophysical |
| Ger | German |
| glac, glacio | glacial, glaciological |
| grad | gradient |
| grav | gravity |
| gthrm, geotherm | geothermal, geothermometry |
| $H_2O$ | water |
| He | Helium |
| Hg | Mercury |
| hist | historic |
| Holo | Holocene |
| HS | Hot Spring |
| hwy | highway |
| hydro | hydrology, hydrological |
| hydrothrm | hydrothermal |
| ig | igneous |
| indx | index |
| inter(p) | interpretation |
| invest | investigation |
| is | island |
| isot | isotope, isotopic |
| K | Potassium |
| K/Ar | Potassium/Argon |
| KGRA | Known Geothermal Resource Area |
| L | lower |
| lith | lithologic(al) |
| mag | magnetic |
| magma | magmatism |
| magmagen | magmagenesis |
| Mak | Makushin |
| meas | measure, measurements |
| meta | metamorphic, metamorphism |
| min | mineral |
| N | north, northern |
| NA | North America(n) |
| NE | northeast, northeastern |
| NPRA | National Petroleum Reserve Alaska |
| NW | northwest, northwestern |
| obs | observations |
| org | origin |
| P. Alex. | Port Alexander |
| paleomag | paleomagnetic |

| | |
|---|---|
| penin | peninsula |
| petro, petrol | petrology |
| Pleist | Pleistocene |
| plumb | plumbing |
| pot | potential |
| prehist | prehistoric |
| prelim | preliminary |
| pri | primary |
| proj | project |
| Q, Quad | quadrangle |
| quakes | earthquakes |
| qual | quality |
| Quat | Quaternary |
| R | river |
| rad, radio | radiometric |
| recon | reconnaissance |
| refr | refraction |
| reg | regulation, regional |
| rept, rpt | report |
| res | resources |
| resis | resistivity |
| Rus | Russian |
| S | south, southern |
| SC | south-central |
| SE | southeast |
| SW | southwest |
| seds | sediments |
| seism,(o) | seismology, seismological, seismicity |
| signif | significant |
| $SnO_2$ | cassiterite |
| spr | spring |
| stat | statistical |
| stdy | study |
| strat | stratigraphy, stratigraphic |
| struct | structure, structural |
| subd, subduct | subduction |
| sum | summary |
| surf | surficial |
| sys | system |
| tect | tectonic |
| temp | temperature |
| Tert | Tertiary |
| therm | thermal |
| trnsfrm | transform |
| us | United States |
| V-D | vapor dominated |
| VTTS | Valley of 10,000 Smokes |
| var | variation |
| volc | volcanic, volcanological, volcano |
| W | West, western |
| weld | welding |
| Wisc | Wisconsinian |

Table 2. Codes used in the short references.

| Code | Topic |
|---|---|
| C | Cultural, socio-economic data, environmental studies |
| DP | Development and planning |
| EF | Economic feasibility studies |
| Eg | Engineering geology, hazard studies |
| Er | Engineering - reservoir |
| Ff | Fluid chemistry - fumaroles |
| Fs | Fluid chemistry - springs |
| Fw | Fluid chemistry - wells |
| Gc | Exploration geochemistry |
| Gr | Geology - regional study |
| Gs | Geology - site specific study |
| H | Historic report |
| HA | Hydrothermal alteration study, includes fumarolic encrustations |
| HS | Heat flow studies and estimates of thermal energy contents |
| PG | Petrology and geochemistry of rocks |
| Pr | Geophysics - regional study |
| Ps | Geophysics - site specific study |
| R | Regional geothermal study |
| RM | Resource model |
| V | Volcanology |
| * | Final report. For those areas with numerous interim and preliminary reports, * indicates a synthesis of all previous work. |

Table 3. Listing of geothermal sites in Alaska with the codes used on the NOAA map. See reference Motyka and others 1983, Geothermal resources of Alaska. Nine additional sites are included here.

Codes AA - Aleutian Arc and lower Alaska Peninsula

| | |
|---|---|
| 1 | Little Sitkin |
| 2 | Semisopochnoi |
| 3 | Kanaga |
| 4 | Adak |
| 5 | Great Sitkin |
| 6 | Korovin |
| 7 | Kliuchef |
| 8 | Milky River |
| 9 | Seguam |
| 10 | Chuginadak |
| 11 | Kagamil |
| 12 | Geyser Bight |
| 13 | Hot Springs Cove |
| 14 | Partov Cove |
| 15 | Okmok Caldera |
| 16 | Makushin Volcano |
| 17 | Glacier Valley |
| 18 | Makushin Valley |
| 19 | Summer Bay |
| 20 | Summer Bay Well |
| 21 | Akutan Volcano |
| 22 | Hot Springs Bay |
| 23 | Akun Strati |
| 24 | Shishaldin |
| 25 | False Pass |
| 26 | Kenmore |
| 27 | Egg Island |
| 28 | Cold Bay |
| 29 | Emmons Lake |
| 30 | Hague |
| 31 | Pavlov |
| 32 | Port Moller |
| 33 | Kupreanoff |
| 34 | Aniakchak |
| 35 | Mother Goose |
| 36 | Chuginagak |
| 37 | Ukinrek |
| 38 | Gas Rocks |
| 39 | Bogoslof |

Codes NC - North Central Alaska

| | |
|---|---|
| 1 | Pilgrim Springs |
| 2 | Pilgrim Wells |
| 3 | Serpentine |
| 4 | Lava Creek |
| 5 | Battleship Mountain |
| 6 | Kwiniuk |
| 7 | Clear Creek |
| 8 | Granite Mountain |
| 9 | Hawk |
| 10 | South |
| 11 | Upper Division |
| 12 | Lower Division |
| 13 | Dulbai |
| 14 | Sun Mountain |
| 15 | Reed River |
| 16 | Hornor |
| 17 | Melozi |
| 18 | Pocahontas |
| 19 | Tunalkten Lake |
| 20 | Little Melozitna |
| 21 | McQuesten |
| 22 | Ishtalitna |
| 23 | Kilo |
| 24 | Upper Ray River |
| 25 | Kanuti |
| 26 | Lower Ray River |
| 27 | Manley |
| 28 | Manley Wells |
| 29 | Hutlinana |
| 30 | Dall |
| 31 | Tolovana |
| 32 | Chena |
| 33 | Circle |
| 34 | Big Windy |
| 35 | Okpilak |
| 36 | Red Hill Spring |
| 37 | Inmachuk |
| 38 | Upper Noatak |
| 39 | Arrigetch |
| 40 | Tetlin |
| 41 | Minook |

Codes SC - South Central Alaska
and upper Alaska Peninsula

1 Ophir
2 Chuilnuk
3 Mt. Martin
4 Mt. Mageik
5 Mt. Griggs
6 Katmai Caldera
7 Mt. Trident
a Snowy Mt.
9 Kukak
10 Mt. Douglas
11 Augustine
12 Iliamna
13 Redoubt
14 Mt. Spurr
15 Willow Well
16 Lower Klawasi
17 Upper Klawasi
18 North Crater Mt. Wrangell
19 Copper Glacier
20 Novarupta
21 Kaguyak
22 Tatlawiksuk
23 Cheeneetnuk
24 White Mountain

Codes SE - South East Alaska

1 White Sulfur
2 Neka Bay
3 Tenakee Inlet
4 North Peril Strait
5 Tenakee
6 Tenakee Wells
7 Nylen
a Fish Bay
9 Goddard
10 Baranof
11 Baker Island
12 Twin Lakes
13 Mt. Rynda
14 Chief Shakes
15 Barnes Lake
16 Bradfield Canal
17 Bailey Bay
18 Bell Island
19 Edgecumbe

Table 4. List of aliases.

| Name of spring used in this report | Names applied to same spring in previous literature |
|---|---|
| Akun Strait | S.W. Akun |
| Aniakchak | Surprise Lake |
| Baker Island | Craig, Dalton |
| Barnes Lake | Paradise |
| Battleship Mountain | Mt. Kachauik |
| Big Windy | Wolfe |
| Chief Shakes | Shakes |
| Circle | Arctic Circle Hot Springs |
| Dulbai | Dulbatna Mt., LeDonne |
| Egg Island | Amak |
| False Pass | Morzhovoi |
| Goddard | Sitka Hot Springs |
| Granite Mountain | Sweepstakes |
| Hague | near Pavlov |
| Kenmore | Stan Christianson |
| Kwiniuk | Elim |
| Lower Division | Division, Souby, Davidson |
| Lower Klawasi | Shrub (Drum Group) |
| Manley | Baker |
| Melozi | Melozitna |
| Milky River | Atka |
| Minook | Conway |
| Mt. Rynda | South Stikine |
| Neka Bay | Nika Bay |
| Partov Cove | Umnak Island |
| Pilgrim | Kruzgumepa |
| Serpentine | Arctic, Spring Creek |
| South | Purcell Mountain |
| Tenakee | Hooniah Hot Spring |
| Twin Lakes | West Shakes |
| Upper Ray | Ray River |
| White Sulfur | Hooniah warm spring |

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ALASKA

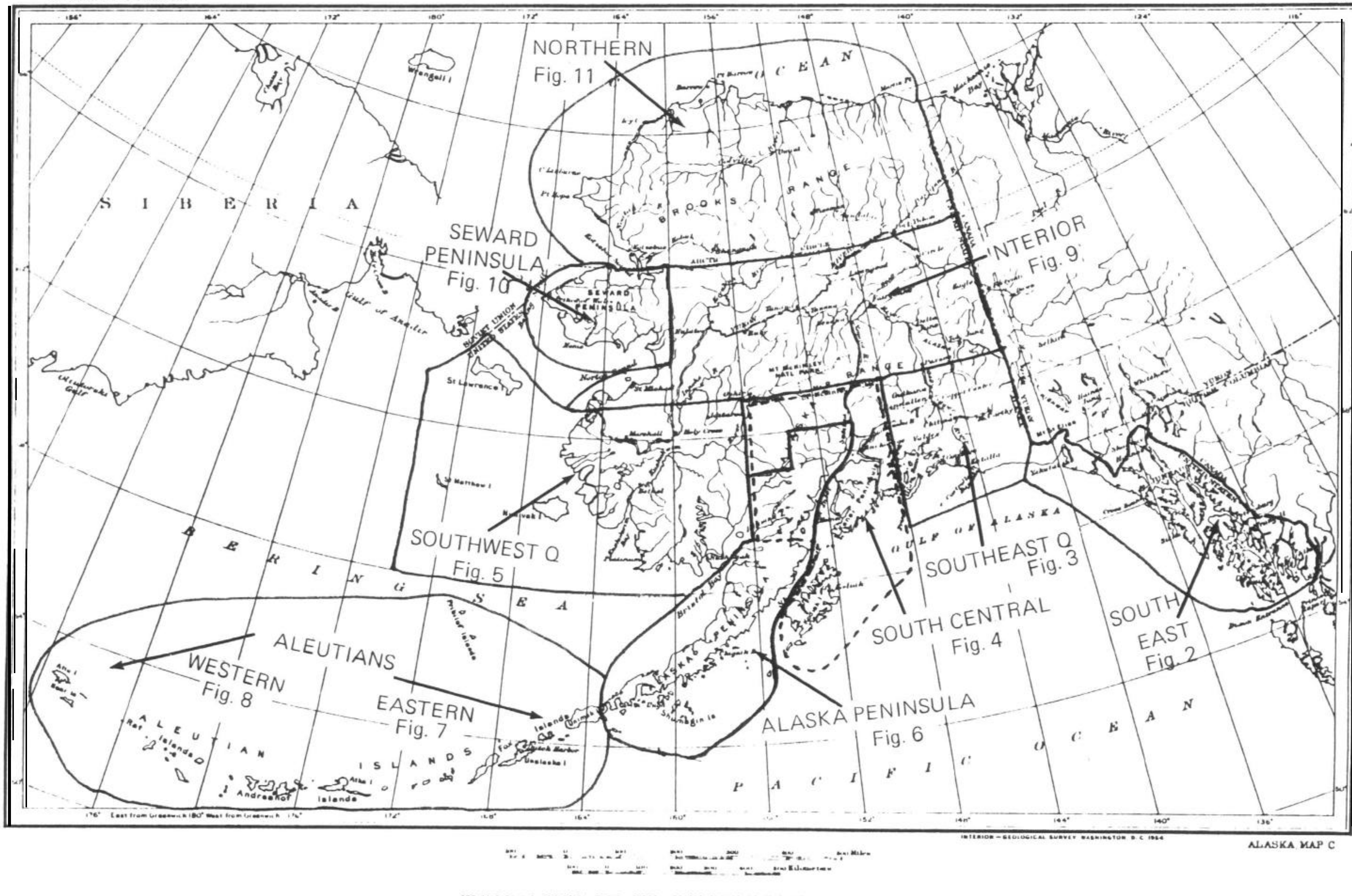




Figure 1. Map of Alaska divided into the 10 geographical regions listed in section IV. Figures 2-11 are enlargements of each of these regions with the individual thermal sites indicated.

FIGURE 2

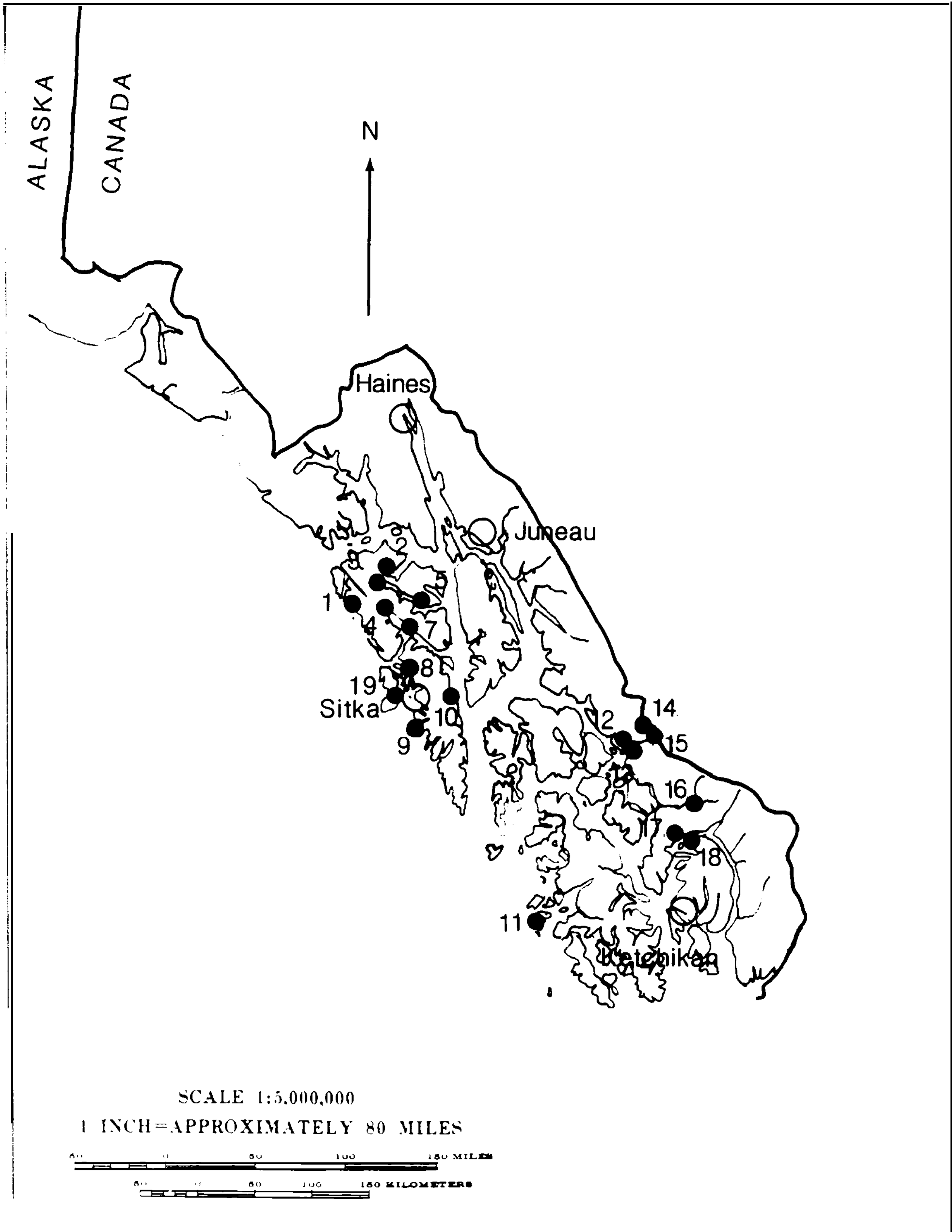


Figure 2. Geothermal spring localities in the region referred to as Southeastern. The numerals correspond to those prefixed by SE on the NOAA map.

FIGURE 3

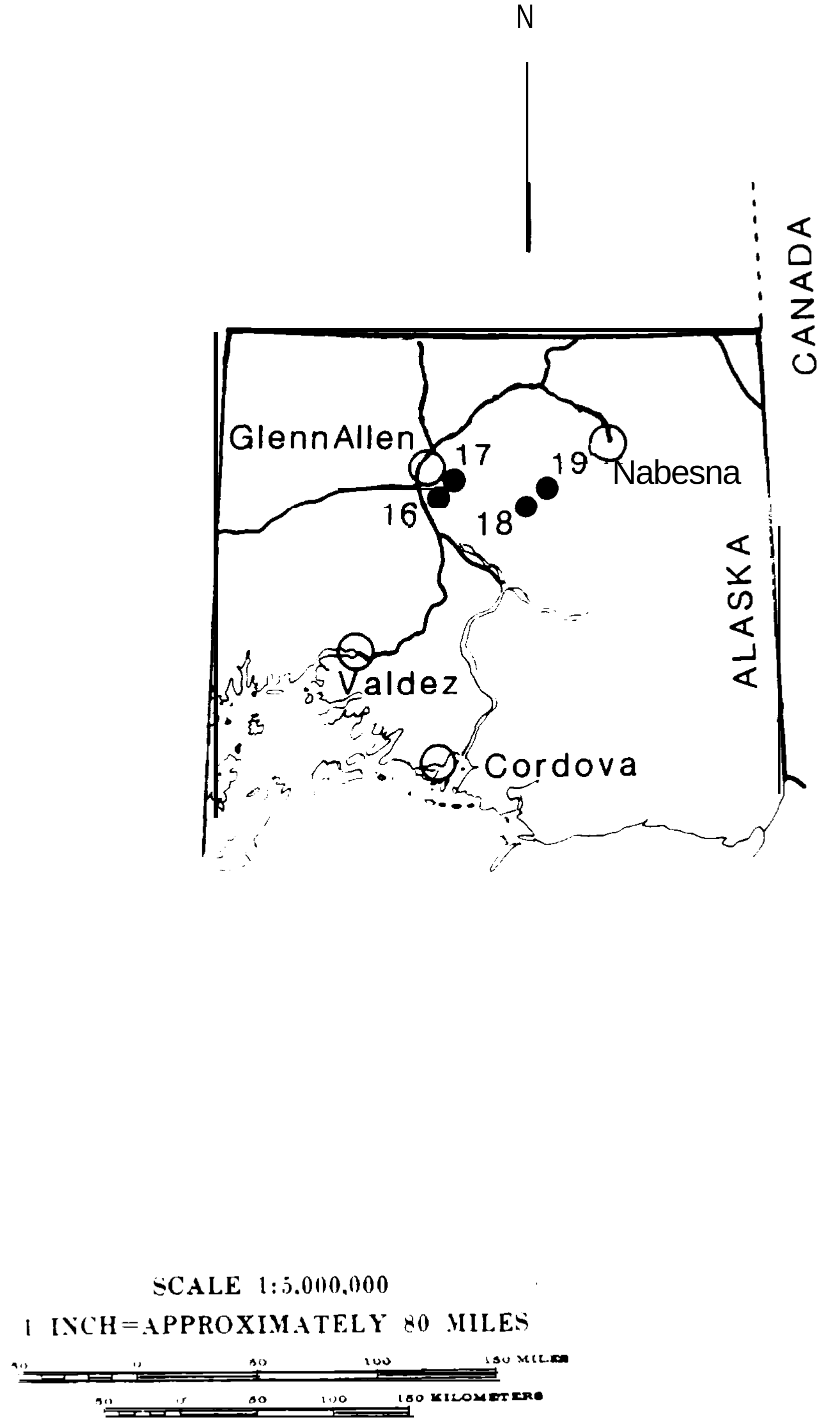


**Figure 3. Geothermal spring localities in the region referred to as Southeast Quadrant. The numerals correspond to those prefixed by SC on the NOAA map.**

FIGURE 4

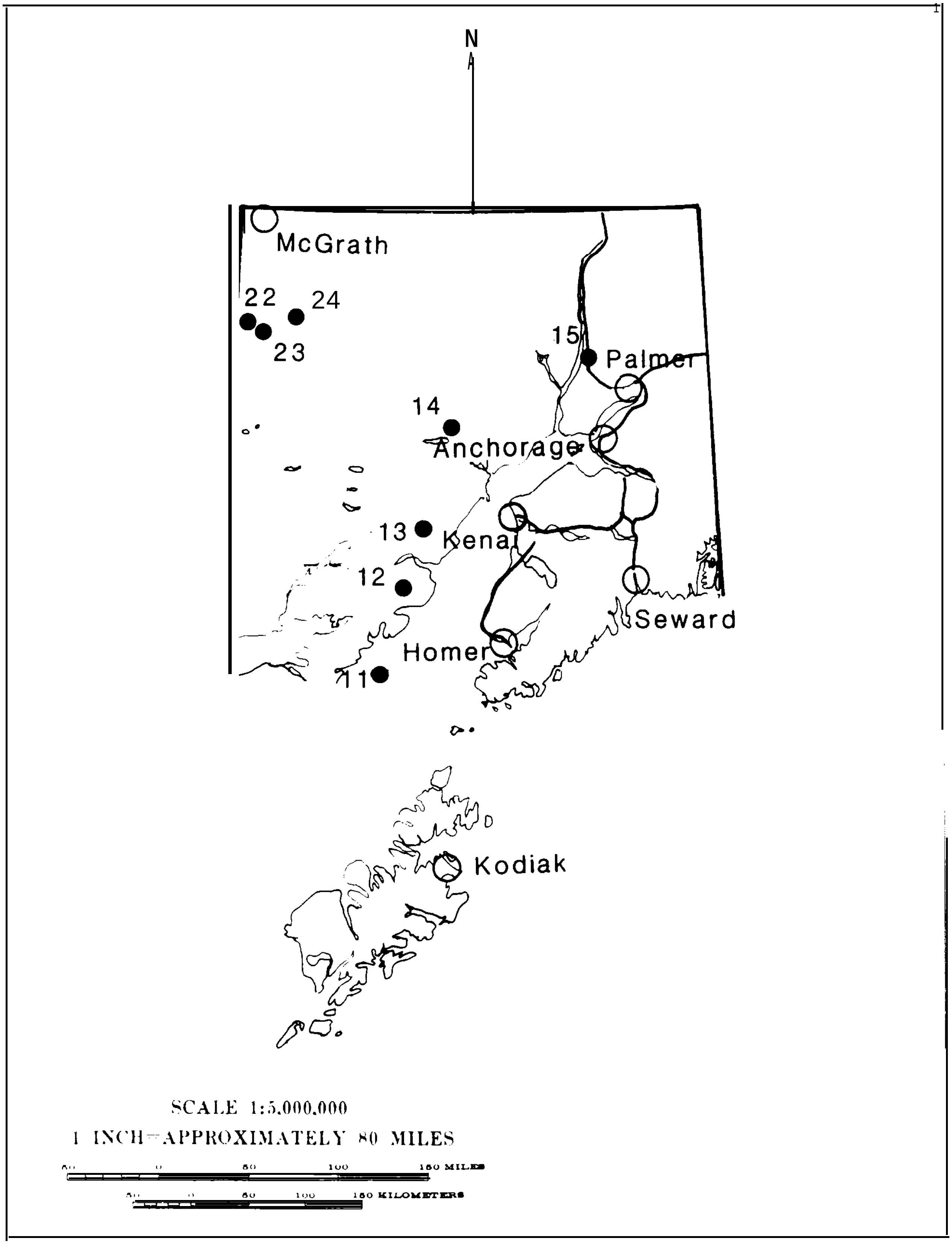


**Figure 4. Geothermal spring localities in the region referred to as South Central. The numerals correspond to those prefixed by SC on the NOAA map.**

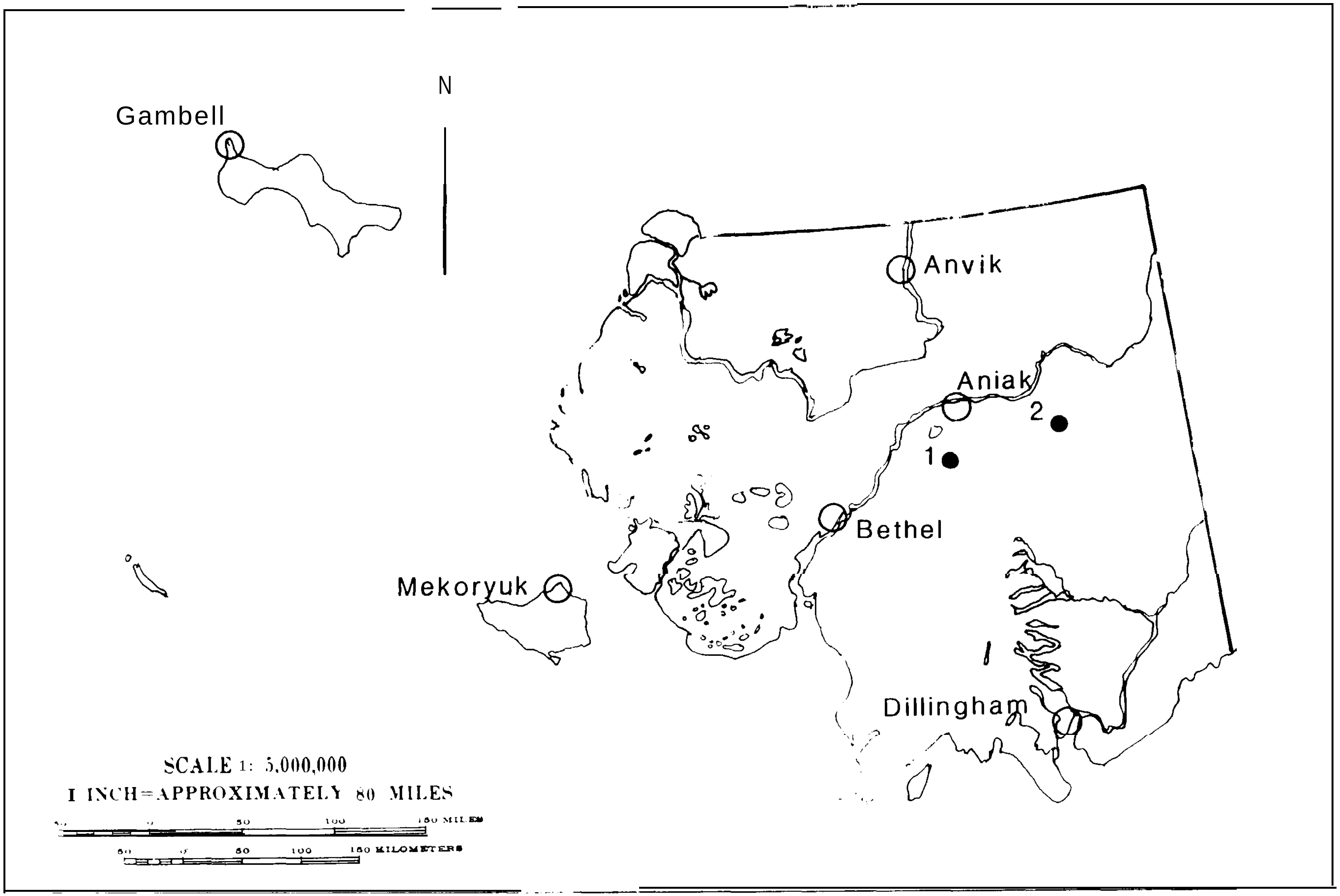


**Figure 5. Geothermal spring localities in region referred to as Southwest Quadrant. The numerals correspond to those prefixed by SC on the NOAA map.**

FIGURE 6

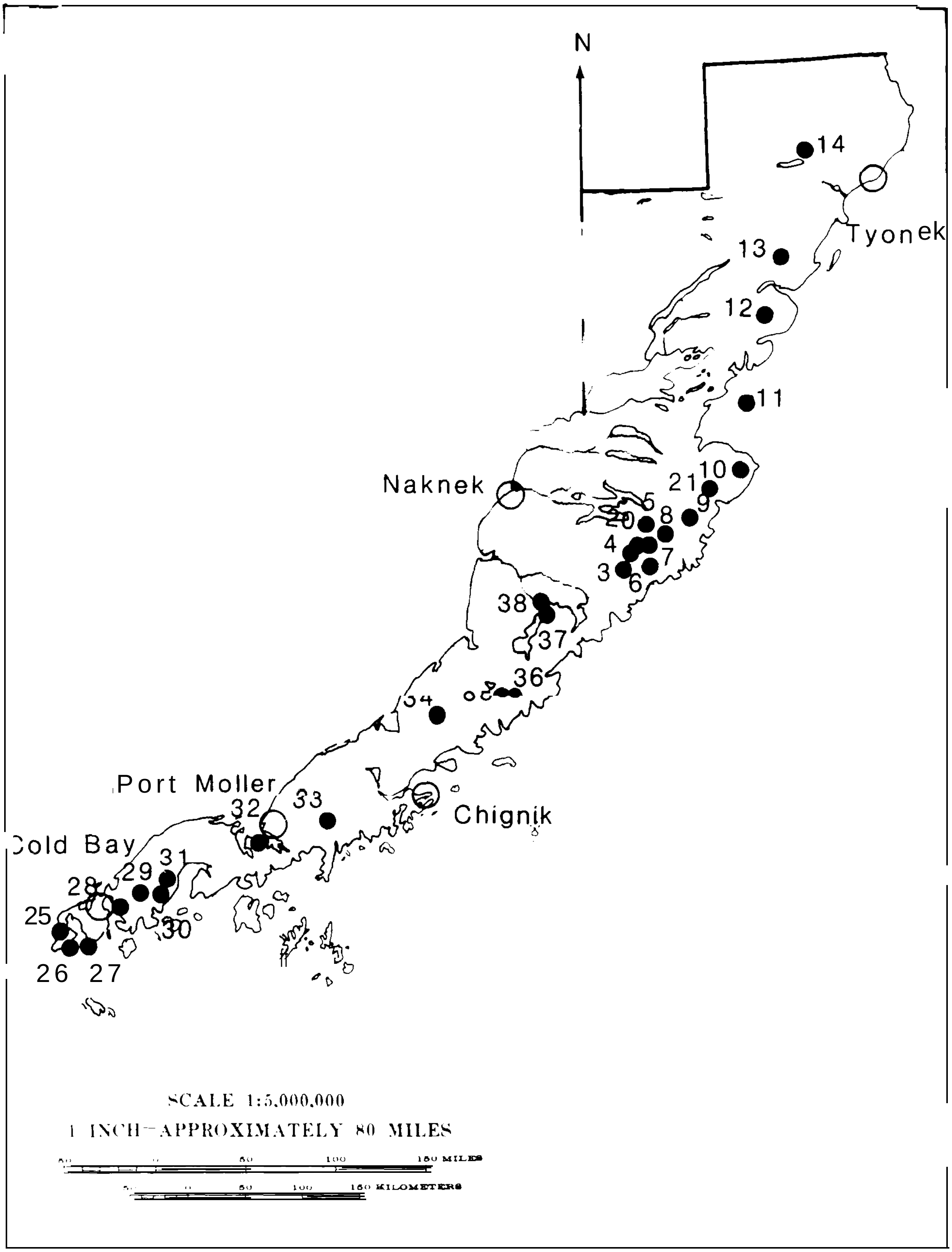


Figure 6. Geothermal spring localities in the region referred to as Alaska Peninsula. Numerals 1-14 correspond to those labeled SC on the NOAA map, and 25-38 correspond to those labeled AA.

**FIGURE 7**

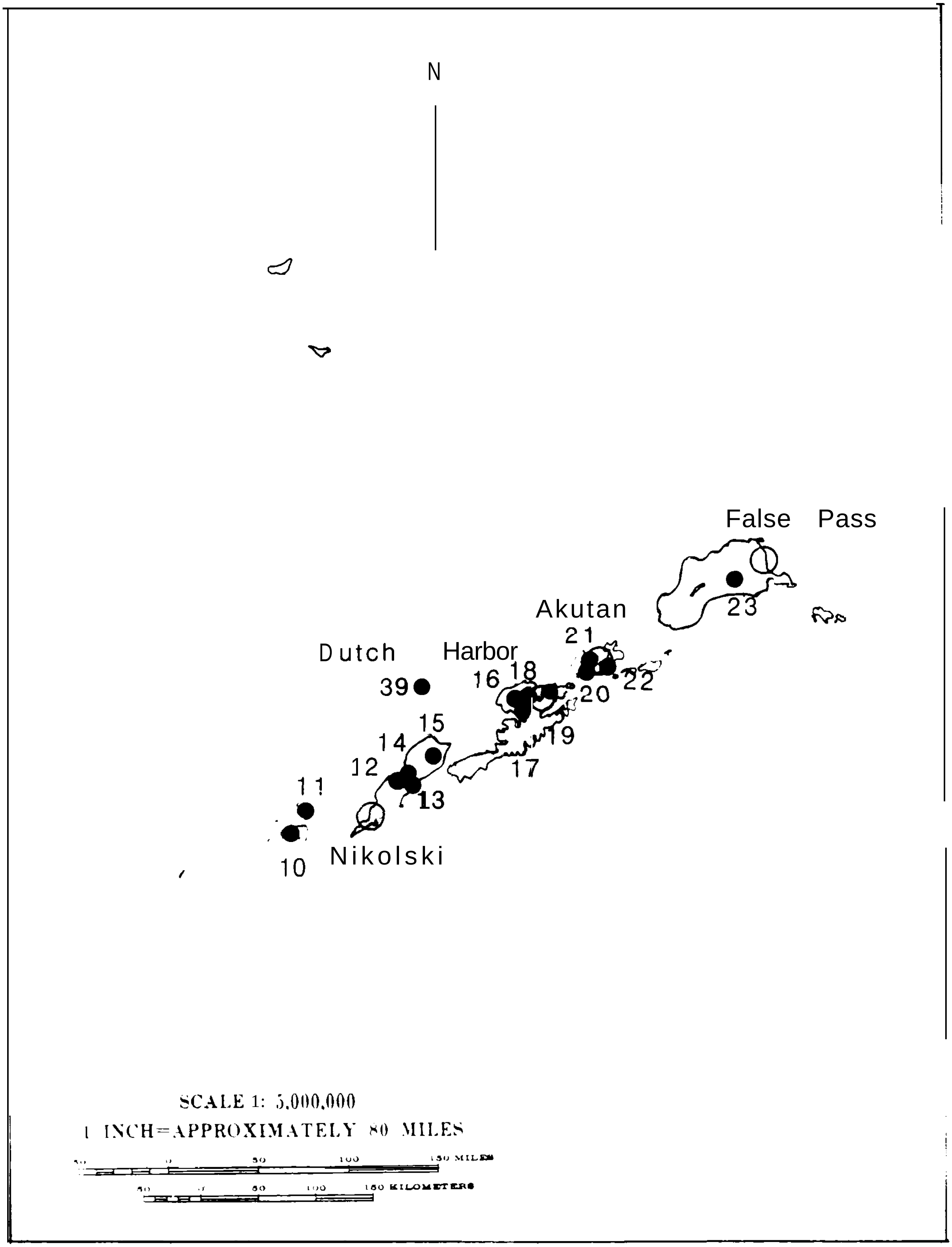


**Figure 7. Geothermal spring localities in the eastern portion of the region referred to as the Aleutians. The numerals correspond to those prefixed by AA on the NOAA map.**

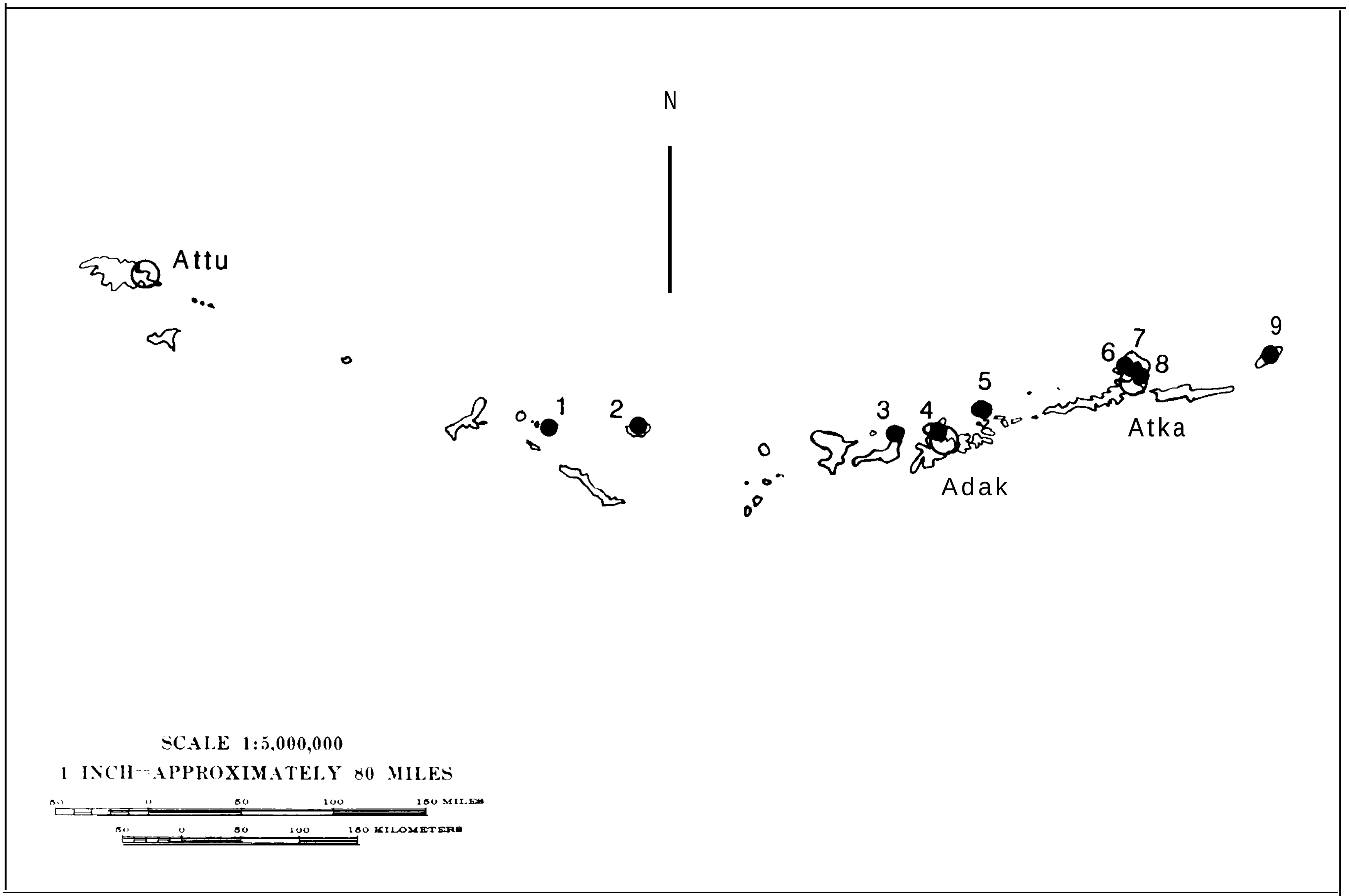


FIGURE 8

**Figure 8. Geothermal spring localities in the western portion of the region referred to as the Aleutians. The numerals correspond to those prefixed by AA on the NOAA map.**

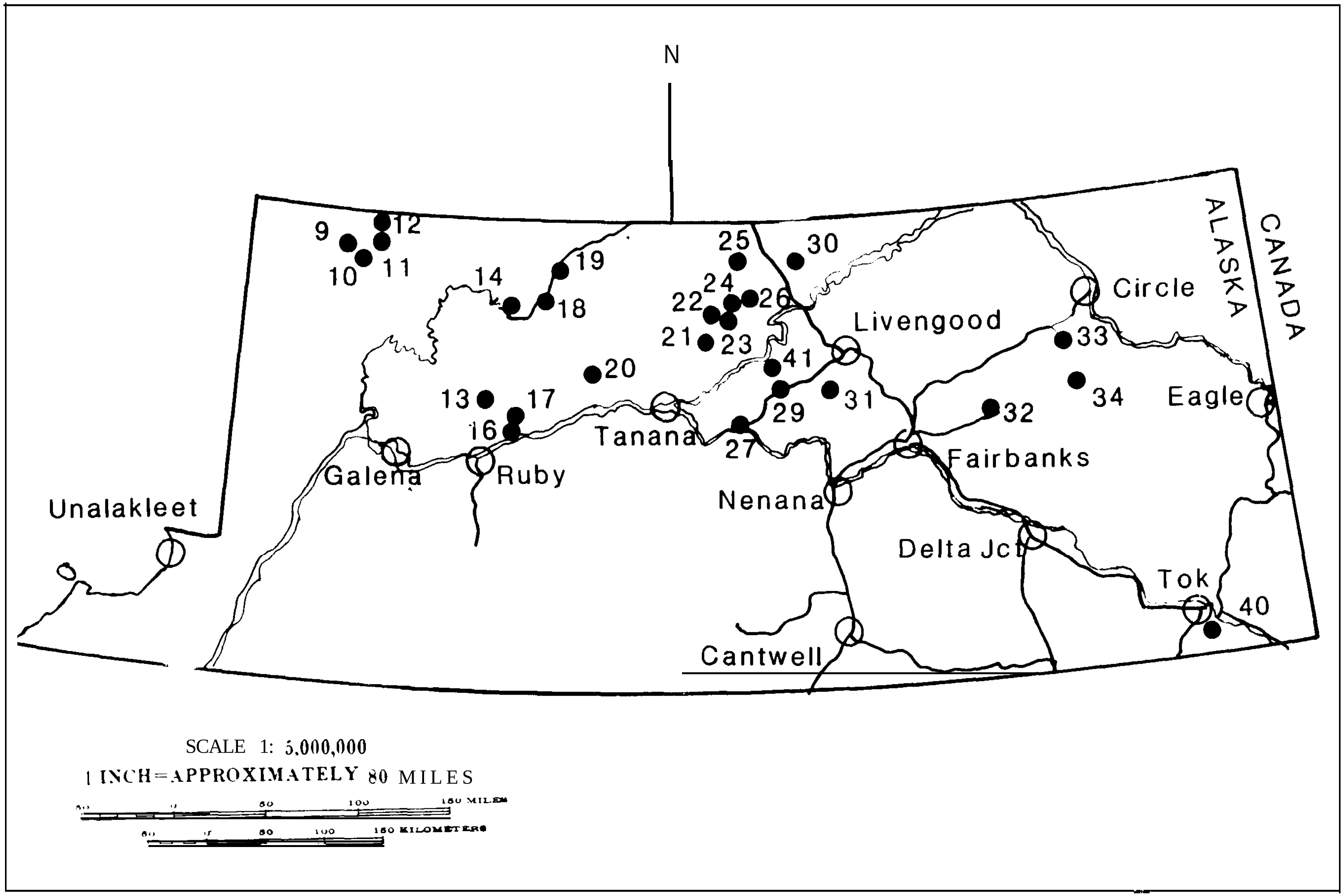


**Figure 9. Geothermal spring localities in the region referred to as the Interior. The numerals correspond to those prefixed by NC on the NOAA map.**

**FIGURE 10**

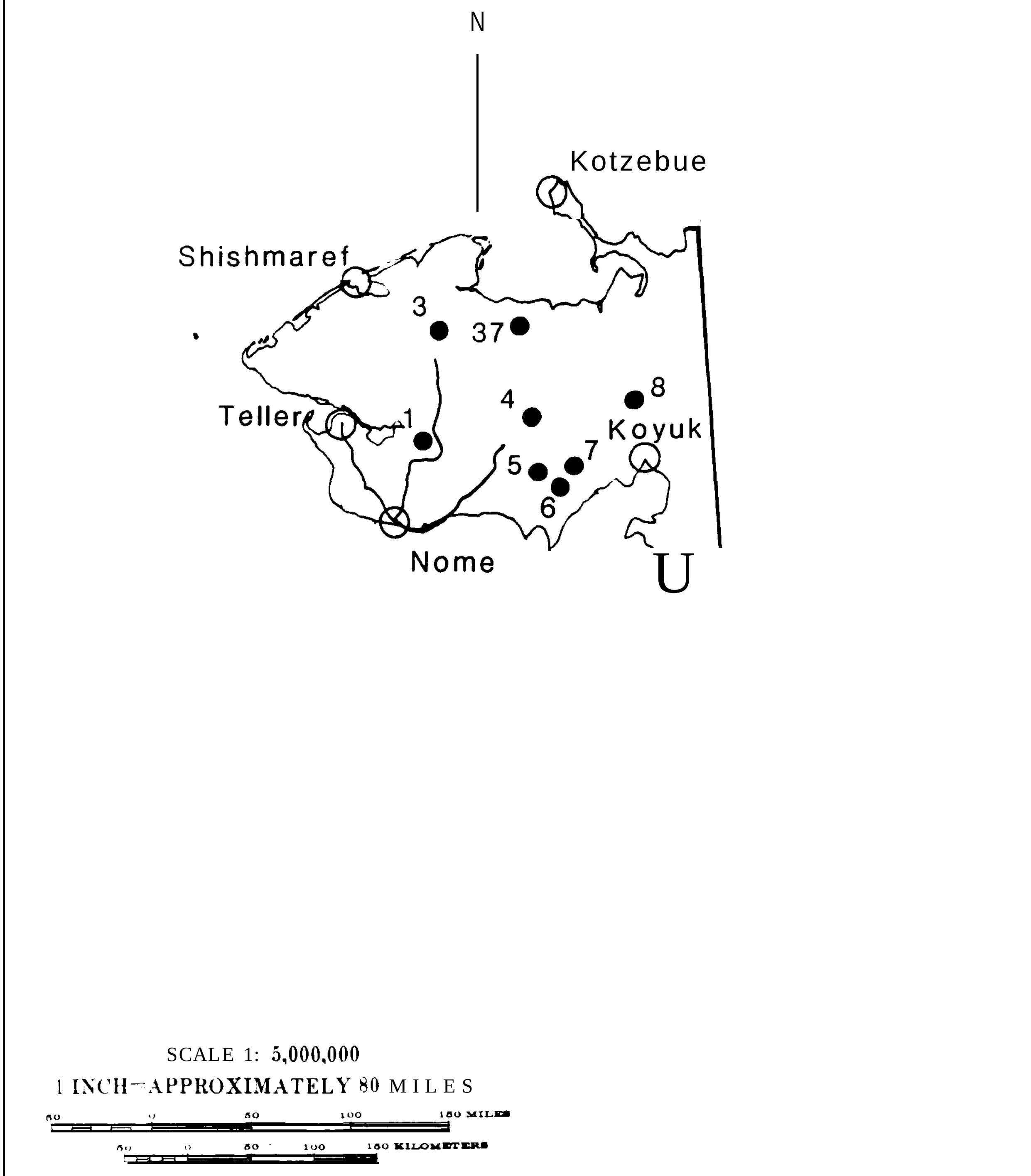


**Figure 10. Geothermal spring localities in the region referred to as the Seward Peninsula. The numerals correspond to those prefixed by NC on the NOAA map.**

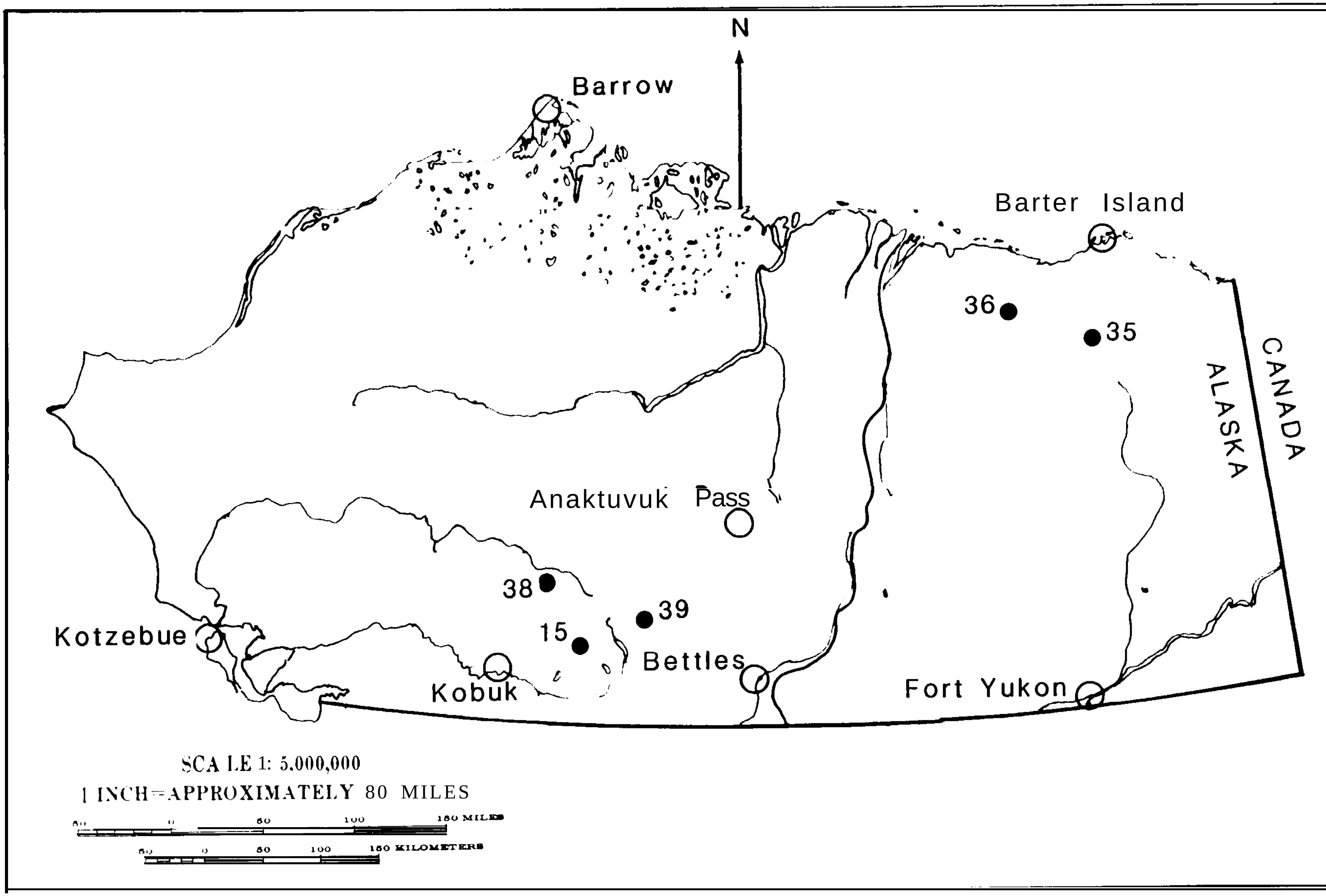


**Figure 11.** Geothermal spring localities in the region referred to as Northern. The numerals correspond to those prefixed by NC on the NOAA map.

FIGURE 11

# APPENDIX A - MAJOR GEOTHERMAL PROJECTS IN ALASKA

## STATEWIDE

The first extensive compilation of information on Alaskan thermal springs was done by Waring, 1917. Since then many additional thermal springs have been discovered and sampled. Several data compilations on Alaskan thermal springs have been published which included additional chemical data that had become available. The most notable of these publications include Miller, 1973, Gassaway and Abramson, 1977, and Turner and others, 1980.

The Alaska Division of Geological and Geophysical Surveys began its assessment of geothermal resources in Alaska in 1979. This program included reconnaissance investigations of as many known thermal sites as possible. Major funding for this project was provided by the State of Alaska and the U.S. Department of Energy. Over 85 of the approximately 120 known thermal sites have now been visited with the major portion of this reconnaissance work being performed between 1979 and 1982. The reconnaissance survey of a thermal site usually included reconnaissance of local geology, geochemical sampling of the thermal fluids, and measurements of vent temperatures and rates of discharge. The location and a summary of thermal sites in Alaska can be found on the statewide geothermal resources map (1:2,500,000) (Motyka and others, 1983). More detailed, technical regional geothermal resources maps at a scale of 1:1,000,000 are currently in preparation. The results of the reconnaissance investigations of thermal sites in the Aleutian Islands and Alaska Peninsula are reported in Motyka and others, 1981; and for southern southeast Alaska in Motyka and others, 1980. Our geochemical analyses of thermal spring waters in Alaska have also been reported in Bliss, 1983.

## ADAK

Saline thermal springs emanate along the Bering Sea coast at the base of Mount Adagdak, a Tertiary-Quaternary volcanic center located northwest of the Adak Naval Base. Geothermometers applied to the spring waters give reservoir temperature estimates of 160" to 190°C. Exploratory drilling on the flanks and base of Mount Adagdak was undertaken by the U.S. Navy in 1977. Temperature gradients measured as high as 80°C/km and the temperature at the bottom of one 600 m deep hole was 66°C. There has been no further exploration since then but the U.S. Navy is considering re-examining the Adak area's geothermal potential. Adak, a strategic military base, has a population of over 3,000 people making it the largest settlement in the Aleutian Islands.

Agencies involved:

Department of the Navy, Naval Weapons Center,
Energy Program Management Office
Department of the Navy, Adak Naval Station
Alaska Division of Geological & Geophysical Surveys
U.S. Geological Survey, Alaska Branch
U.S. Fish and Wildlife Service

## AKUTAN

Several thermal springs and a small fumarole field are located in Hot Springs Bay Valley, about 4 km northwest of Akutan Harbor and 10 km northeast of active Akutan Volcano. The chloride-rich springs have surface discharge temperatures ranging from 40" to 85°C; geothermometers give reservoir temperature estimates of 180" to 190°C. Geophysical investigations suggest that much of the valley is underlain by warm waters. The resource area lies close to a small but well-protected natural harbor that serves as the base of operations for several bottom-fishing and crabbing vessels, floating fish processors and a shore-based bottom-fish processing plant. Geothermal resources in the valley have the potential of supplying all the energy needs, through direct use and electrical power generation, for the processors and the nearby village of Akutan.

Agencies involved:
- Alaska Division of Geological & Geophysical Surveys
  - Geophysical Institute, University of Alaska
- Akutan Village Council
- Aleut Corporation
- U.S. Fish and Wildlife Service

## ATKA

Two major fumarole fields, Kliuchef and Milky River and associated low-Cl, $HCO_3$-$SO_4$ rich thermal springs are located on the west flank of the strato-volcano, Mt. Kliuchef. A third geothermal field, Korovin, lies in a valley about 6 km southwest of Korovin Volcano. Gas geothermometry gives reservoir temperature estimates of 170" to 300°C. The nearby native village of Atka has a subsistence based economy and is actively seeking an energy source to help develop a local commercial fishing industry. The proximity of the geothermal resources on northeast Atka to a good harbor and potential users make the area particularly attractive for further exploration.

Agencies involved:
- Alaska Division of Geological & Geophysical Surveys
- Atka Village Council
- Aleut Corporation
- U.S. Fish and Wildlife Service

## BARANOF

Waters from eight thermal springs ranging from 40" to 50°C in temperature are used to heat local dwellings, a general store and a commercial bath house. The estimated reservoir temperature, based on geothermometry, is 95°C. The springs flow from fractures in an Eocene trondhjemite pluton. The site lies within the Tongass National Forest.

Agencies involved:
- Alaska Division of Geological & Geophysical Surveys
- U.S. Forest Service, Tongass National Forest

## BELL ISLAND and BAILEY BAY

At Bell Island, waters from numerous springs ranging in temperature from 67" to 74°C are collected in cisterns and used to heat lodges, cabins, and the swimming pool of a fishing resort complex. The owner has expressed interest in cascaded direct-use of the thermal spring waters for greenhouses and aquaculture. Geothermometers give an estimated reservoir temperature of 135°C. Nearby Bailey Bay Hot Springs have surface discharge temperatures as high as 91°C and an estimated reservoir temperature of 150°C. The U.S. Forest Service has proposed placing the Bailey Bay site into an ecological preserve status.

Agencies involved:
Alaska Division of Geological & Geophysical Surveys
U.S. Forest Service, Tongass National Forest
Bell Island Hot Springs Fishing Resort

## CHENA and CIRCLE

These sites are both examples of hydrothermal resources resulting from the percolation and circulation of meteoric waters along fractures and faults in Cretaceous intrusive bodies and overlying metamorphic units in central Alaska. Additionally both have similar histories of development and direct use, first serving local mining communities as bathing and small-scale agricultural facilities, and later becoming major recreational areas for residents of Fairbanks. At Circle water from nine springs, with a maximum temperature of 60°C and combined flow of 1,700 lpm, is used to heat a large hotel, swimming pool, and small greenhouse. At Chena effluent from 10 springs, with a combined flow of 840 lpm and maximum temperature of 57°C, is used to heat a lodge and enclosed swimming pool. Owners of both resorts would eventually like to drill wells to increase hot water production, but are presently working to expand the direct use of natural discharge. Based on geothermometry, estimated reservoir temperatures for both sites are 130" to 145°C.

Agencies involved:
Alaska Division of Geological & Geophysical Surveys
Geophysical Institute, University of Alaska
U.S. Geological Survey, Alaska Branch
Chena Hot Springs Resort
Circle Hot Springs Resort

## GODDARD

Four springs ranging in temperature from 30" to 66°C are located 22 km south of Sitka on the coast of Baranof Island. Geothermometry gives a reservoir temperature estimate of 140°C. The site was developed as a health spa complete with hospital facilities during the 1920's. The spring waters are currently used for community bath houses. The city of Sitka, which owns the springs, has considered further development of the area but the Sitka community residents have expressed their desire to maintain the area as a recreational site.

Agencies involved:
Alaska Division of Geological & Geophysical Surveys
Sitka City and Borough Government

## KLAWASI - COPPER RIVER BASIN

Two groups of mud volcanoes are located in the Copper River Basin: the Tolsana group west of Glennallen and the Klawasi group east of Glennallen. Although both groups discharge highly saline waters, the Klawasi group is distinguished by warmer waters (20°C) accompanied by vast amounts of C02. The saline waters emanating from both groups are thought to originate from over-pressured zones in Cretaceous marine sediments that underlie the basin. The proximity of the Klawasi group to the extremely large Quaternary volcanoes of the western Wrangell Mountains lead many to speculate that a significant geothermal resource might underlie the mud volcanoes. This view was supported when researchers from the Geophysical Institute, University of Alaska found gravity, magnetic, self-potential, and helium anomalies in the Klawasi area, the combination of which they suggested might indicate hydrothermal activity. However, recent geochemical and isotopic investigations of the mud volcano fluids by DGGS have shown that the reservoirs feeding the Klawasi mud volcanoes are probably of moderate temperature (100° to 125°C). Fluid geochemical and isotopic evidence also suggests that a body of magma has intruded deep-seated limestone formations beneath the Klawasi area and is responsible for the production of the large quantities of $CO_2$ through thermogenic and geochemical processes. Land ownership in the region is divided among the local native corporation, the State of Alaska, and the National Park Service.

Agencies involved:

Alaska Division of Geological & Geophysical Surveys
Geophysical Institute, U. of Alaska
U.S. Geological Survey, Alaska Branch
Wrangell - St. Elias National Park
AHTNA - Copper River Native Association

## MAKUSHIN

The Makushin geothermal area is associated with Makushin Volcano, a major volcanic center in the Aleutian arc. The hydrothermal system consists of a boiling hot-water reservoir overlain by a discontinuous vapor-dominated zone that discharges steam and gases from several fumarole fields located on the south and east flanks of the volcano. Numerous low-Cl, $HCO_3$-$SO_4$ rich thermal springs emanate downslope from the fumaroles; several alkali-Cl, $HCO_3$-$SO_4$ rich thermal springs occur at lower elevations. Gas geothermometry applied to a 150°C superheated fumarole gives a reservoir temperature estimate of 300°C. Host reservoir rock is a highly-fractured gabbro-norite stock. Reconnaissance investigations of the area's geothermal resources were undertaken by the Alaska Division of Geological and Geophysical Surveys in 1980 and 1981 under a program funded by the U.S. Department of Energy and the State of Alaska. From 1982-1984 the Alaska Power Authority administered a state funded $5 million exploratory drilling program with Republic Geothermal, Inc. of California the prime contractor. Three 460 m deep thermal gradient holes were drilled in 1982. The hottest temperature encountered was 195°C at the bottom of the hole drilled at the head of Makushin Valley. In 1983 a 593 m test well (ST-l) drilled near the same site verified that a resource suitable for generating electrical power exists. Bottom hole temperature measurements were 195°C with geothermometers indicating deeper reservoir temperatures of 220°C and higher. Engineering tests indicate that the single fracture encountered could supply two production wells each capable of driving a 5 MW turbine. In 1984, electrical resistivity surveys and an additional thermal gradient hole drilled to 490 m near Sugarloaf Cone delineated the north and east boundaries of the wedge shaped main reservoir which dips to the south and west of ST-l. The conclusion of all results indicate that the hydrothermal fluids which feed ST-l are derived from a deep parent reservoir approximately centrally located beneath the volcano and any future production wells should be sited at or upvalley of ST-l. A geological engineering and hazards study of the site has been recently completed by DGGS. The resource area lies 25 km west of the village of Unalaska and Dutch Harbor, the largest natural deep-water harbor in the Aleutian Islands. The village and harbor serve as the major base of operations for the rich North Pacific and Bering Sea fisheries and for oil and gas exploration on the Bering Sea shelf. The 10 MW electrical power needs of the community and fish processing industry is currently supplied by diesel-fired generators.

Agencies involved:
- Alaska Division of Geological & Geophysical Surveys
- Alaska Power Authority
- Geophysical Institute, University of Alaska
- Republic Geothermal Inc., California
- Ounalashka Corporation
- Unalaska Village Council
- Aleut Corporation
- U.S. Fish and Wildlife Service
- Alaska Department of Fish and Game
- Alaska Division of Oil and Gas

## MANLEY

Hot springs at Manley, centered on the 236-acre Dart homestead, are used to heat a house, large greenhouses, and a small commercial bath, as well as providing the primary water supply for the community of Manley. Discharge temperatures range from 18" to 61°C, with reservoir estimates of 70" to 130°C. The Bean Ridge Native Corporation has selected all available land surrounding the Dart property and are interested in geothermal exploration and development. Geophysical and geochemical studies have been carried out to help site a well on the Dart property. Capital limitations prevent immediate development of the resource, but a potential for greater direct use of spring waters exists. From 1906 to 1912 Manley was the site of the most extensive direct use of geothermal energy to date in Alaska. During the height of placer mining activity in the Tofty, Eureka, and Baker Cr. areas, Manley served as a trade center which boasted a 60 room hotel, public baths, extensive poultry, hog and dairy barns, greenhouses and commercial truck gardens all heated with geothermal energy.

Agencies involved:
- Geophysical Institute, University of Alaska
- Alaska Division of Geological & Geophysical Surveys
- Bean Ridge Native Corporation
- Manley Hot Springs Resort

## MOUNT SPURR

Mount Spurr is a large andesitic stratovolcano located on the west side of upper Cook Inlet. The volcano last erupted in 1953 scattering ash over Anchorage 130 km to the east. Surface manifestations of geothermal activity include a 1 km long zone of warm springs (40°C) in the valley immediately south of Crater Peak, a fumarole field around Crater Peak, and evidence of ice melting by hydrothermal activity at an elevation of 2,900 m. Preliminary results of geological and geochemical studies of Mount Spurr volcanic rocks by DGGS and the University of Alaska provide abundant evidence for a shallow-level magma system which has been active during late Pleistocene and Holocene time. Geophysical and geochemical surveys were conducted in 1985 by the University of Alaska, Geophysical Institute in the area south of Mount Spurr. These investigations located large electrical self-potential anomalies and extensive zones of low resistivity which are overlapped and surrounded by areas of anomalously high He and Hg values. The south side of Mt. Spurr has been the site of two State of Alaska geothermal lease sales. The lease holders are actively exploring for geothermal resources which they plan to use for agricultural purposes. Anchorage presently obtains most of its electricity from turbines fired by natural gas from the upper Cook Inlet oil fields. A part of Mt. Spurr lies within a National Park.

Agencies involved:
- Geophysical Institute, University of Alaska
- Alaska Division of Geological & Geophysical Surveys
- Alaska Division of Oil and Gas
- U.S. Geological Survey, Alaska Branch

## PILGRIM

Two hot springs (81°C) and a large oval of thawed ground in an area of deep continuous permafrost are surface manifestations of geothermal resources in the Pilgrim River valley 75 km north of Nome, Alaska. The valley is believed to be a downdropped fault block of pre-Phanerozoic gneiss and intrusive Mesozoic granites which is overlain by a thick (200 m) sequence of Tertiary (?) sediments. A shallow pancake-shaped hot water reservoir (1 $km^2$) was postulated from reconnaissance geologic, geophysical, hydrologic and geochemical studies conducted by the Geophysical Institute, University of Alaska and DGGS. The reservoir was later substantiated by six geothermal gradient wells drilled under contract to the Alaska Division of Energy and Power Development during 1979 and 1982. The reservoir, 14 m below the surface, is 20 m thick and 91°C. No deep conduit was discovered and the source for the heat is still in question. Cation and silica geothermometers predict reservoir temperatures of 110” to 148°C. There is probably 19 MW available for local direct-use development. A road now connects Nome to the springs which are used currently for recreation. Future development is uncertain. The springs and surrounding land are owned by the Catholic Church.

Agencies involved:
- Geophysical Institute, University of Alaska
- Alaska Division of Geological & Geophysical Surveys
- Alaska Department of Commerce and Economic Development
- Woodward-Clyde Consultants

## SUMMER BAY

Two thermal springs located near the village of Unalaska about 2 km up-valley from Summer Bay on Unalaska Island, feebly emit chloride-rich 30°C waters. In 1980 two shallow test wells spaced 200 m apart were drilled into iron-stained sediments located on the shore of a lake about 1/2 km downvalley from the springs. Both wells encountered a warm water aquifer at about 13 m and bedrock at 17 m. Artesian flow from well 1 was 180 lpm at 50°C; well 2 flow was 30 lpm and 44°C. The wells have been plugged and the geothermal resource remains un-utilized.

Agencies involved:

Alaska Division of Geological & Geophysical Surveys
Alaska Department of Commerce and Economic Development
Ounalashka Corporation
Unalaska Village Council

## TENAKEE

Eighteen springs ranging from 30" to 40°C in temperature lie along the shoreline at Tenakee Village. The springs appear to originate as meteoric waters that circulate along deep fractures associated with nearby fault zones. Geothermometry gives reservoir temperature estimates of 65" to 100°C. Waters from one of the springs is used for a community bath house. Under a U.S. Department of Energy Program, the Alaska Department of Commerce and Economic Development contracted for exploratory drilling to determine whether hot waters suitable for direct-use were present at shallow depths. Six test wells were drilled; the deepest reached 30 m (100 ft.) and produced 30°C waters at a rate of about 8 lpm. Water temperatures and flow rates from the wells were deemed insufficient for district heating.

Agencies involved:

Alaska Division of Geological & Geophysical Surveys
Alaska Department of Commerce and Economic Development
Village of Tenakee

## UMNAK

Numerous hot springs, fumaroles, and several small geysers with temperatures to 102°C are located in Geyser Bight Valley, and constitute probably the best known, most widespread, and hottest thermal spring system in Alaska. Silica and cation geothermometers give reservoir temperature estimates of 180" to 200°C; sulfate-water oxygen isotope geothermometry suggests deep reservoir temperatures are as high as 265°C. The resource area lies between huge Okmok Caldera to the northwest and Mount Recheschnoi and Vsevidof, two large stratovolcanoes, to the southwest. Chloride thermal springs also occur in neighboring Hot Springs Cove and Partov Cove valleys. Lands in the Geyser Bight and surrounding areas have been selected by the State of Alaska, Nikolski Village Corporation, St. George Village Association and the Aleut Corporation. The nearest community is the native village of Nikolski, 40 km southwest of Geyser Bight. Because of the remoteness of the three sites, the lack of protected deep-water harbors, and low population base, geothermal resource development appears unlikely in the near future.

Agencies involved:

Alaska Division of Geological & Geophysical Surveys
U.S. Geological Survey
U.S. Fish and Wildlife Service
Aleut Corporation
Nikolski Village Council
St. George Village Association

## WILLOW - LOWER SUSITNA BASIN

Four nonproducing exploratory oil wells drilled into the thick Tertiary sedimentary sequence overlying granitic basement rocks in this area had geothermal gradients of 41” to 123°C/km. Limited geophysical and geochemical data from the area have been interpreted by Turner and Wescott (1982) as possibly indicating a shallow low-grade geothermal reservoir 100 $km^2$ in area, that could be tapped for direct use. There is no surface manifestation of the resource, no fluids were encountered in the wells, and the source of the heat remains highly speculative. Traditionally an area of small-scale agricultural activity, it has recently seen extensive suburban development. Other potential users include the State Division of Parks, Nancy Lake Recreation Area.

Agencies involved:

Geophysical Institute, University of Alaska

## APPENDIX B - AGENCIES INVOLVED IN ALASKA GEOTHERMAL RESOURCES

### EXPLORATION AND ASSESSMENT

Federal/ State

U.S. Department of Energy, Idaho Operations Office, 785 COE Place, Idaho Falls, ID 83402.

U.S. Geological Survey, Branch of Igneous and Geothermal Processess, MS-910, 345 Middlefield Rd., Menlo Park, CA 94025.

U.S. Geological Survey, Water Resources Division, MS-34, 345 Middlefield Rd., Menlo Park, CA 94025.

U.S. Geological Survey, Alaska Branch, Gould Hall, Alaska Pacific University, Anchorage, AK 99501.

U.S. Department of the Navy, Naval Weapons Center, Energy Program Management Office, China Lake, CA 93555-6001.

Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, 3700 Airport Way, Fairbanks, AK 99709-4699; Pouch 7-028, Anchorage, AK 99510; P.O. Box 772116, Eagle River, AK 99577; 400 Willoughby Center, 3rd Floor, Juneau, AK 99801.

Alaska Power Authority, 701 E Tudor Road, P.O. Box 190869, Anchorage, AK 99519-0869.

University of Alaska
- Geophysical Institute
- Geology Department
- Petroleum Engineering Department
- Fairbanks, AK 99755.

Alaska Department of Fish & Game, Division of Fisheries Rehabilitation, Enhancement & Development, 333 Raspberry, Anchorage, AK 99518; P.O. Box 3-2000, Juneau, AK 99802.

Private

Dames & Moore, 800 Cordova, Suite 101, Anchorage, AK 99501.

Geothermal Resources International Exploration Co., 1825 S. Grant St., Suite 900, San Mateo, CA, 94402.

Premier Geophysics Inc. 1184 Forge Walk, Vancouver, BC, Canada V6H-3P9.

Republic Geothermal, 11823 E. Slauson Ave, Sante Fe Springs, CA, 90670.

William Ogle, 3801 W 44th Ave, Anchorage, AK 99502.

Woodward-Clyde, One Walnut Creek Center, 100 Pringle Ave, Walnut Creek, CA 94596 (Ben E. Lofgren).

### ECONOMIC DEVELOPMENT

Ahtna' T'aene Nene', Copper River Native Association, Drawer G, Copper Center, AK 99573.

Akutan Village Council, Akutan, AK 99553.

Alaska Department of Commerce and Economic Development, Suite 722 Frontier Building, 3601 'C' Street, Anchorage, AK 99503; P.O. Box D, Juneau, AK 99811.

Alaska Power Authority, 701 E. Tudor Road, P.O. Box 190869, Anchorage, AK 99519-0869.

Aleut Corporation, 2550 Denali, Suite 900, Anchorage, AK 99503.

Atka Village Council, Atka, AK 99502.

Bean Ridge Native Corporation, Manley Hot Springs, AK 99756.

Dennis P. Carroll, Box 80562, Fairbanks, AK 99708.
Chaluka Corporation, Nikolski, AK 99638.
Roger & Barbara Cotting, Chena Hot Springs Corp., 1919 Lathrop St., Drawer 25, Fairbanks, AK 99707.
Chuck Dart, Manley Hot Springs, AK 99756.
Jim Dawson & Bud Seltenreick, 2165 Dawson Road, North Pole, AK 99705.
Tom Delong, P.O. Box 83058, Fairbanks, AK 99708
Suzan Dilley, SR 2690, Wasilla, AK 99687.
False Pass Native Corporation, False Pass, AK 99583.
Dolly Faulkner, P.O. Box 246, Bethel, AK 99559.
Geothermal Resources International Exploration Co., 1825 S. Grant St., Suite 900, San Mateo, CA 94402.
Doris Loennig Attorney, 515 7th Ave., Fairbanks, AK 99701.
Robert Miller, P.O. Box 729, Fairbanks, AK 99707.
Ounalashka Corporation, P.O. Box 149, Unalaska, AK 99685.
Don Peterson, Box 8762, Ketchikan, AK 99901.
C.J. Phillips, Nome, AK 99762.
Richard Rome & Donna Waidtlow, 12404 NE 29th St., Bellevue, WA 98005.
Seth-de-ya-ah Native Corporation, P.O. Box 849, Fairbanks, AK 99707.
City of Sitka, Box 79, 304 Lake St., Sitka, AK 99835.
St. George Village Association, St. George Island, AK 99660.
Tanadquisix Village Corporation, St. Paul Island, AK 99660.
City of Tenakee Springs, P.O. Box 52, Tenakee Springs, AK 99841.
Unalaska Village Council, Unalaska, AK 99685.

## LEASING, PERMITTING AND REGULATORY

### Federal/State

U.S. Bureau of Land Management, Fairbanks Support Center, 1541 Gaffney, Fairbanks, AK 99703-1399.
U.S. Fish and Wildlife Service, 1011 E. Tudor Rd., Anchorage, AK 99503; Aleutian National Wildlife Refuge, Box 5251, Seattle, WA 98791.
U.S. Forest Service, 709 W. 9th St., Juneau, AK 99801; Tongass Forest Manager, 9 1/2 Mile Glacier Hwy, Juneau, AK 99801.
U.S. Environmental Protection Agency, Region X, 1200 6th St. Seattle, WA 98101.
Alaska Department of Natural Resources, Division of Oil and Gas, 3601 ‘C' St., P.O. Box 7034, Anchorage, AK 99510-0734.
Alaska Department of Natural Resources, Division of Land and Water Management, 3601 ‘C' St., P.O. Box 7005, Anchorage, AK 99510-0734.
Alaska Department of Fish and Game, 333 Raspberry Rd., Anchorage, AK 99502; P.O. Box 3-2000, Juneau, AK 99802.
Alaska Department of Environmental Conservation, 437 ‘E' Street, Suite 200, Anchorage, AK 99501.

## MISCELLANEOUS

U.S. National Oceanic and Atmospheric Administration, 600 Spruce St., Boulder, CO 80302.
University of Utah Research Institute, 391 Chipeta Way, Suite C, Salt Lake City, UT 84108.
U.S. National Park Service, Alaska Regional Office, 540 W. Fifth Ave., Anchorage, AK 99501.