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# RECONNAISSANCE GEOLOGY OF AMLIA ISLAND, ALEUTIAN ISLANDS, ALASKA

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ABSTRACT

Amlia Island, located in the central part of the Aleutian Island chain, exhibits excellent shoreline exposures of Paleogene sedimentary and volcanic rocks, which record the earliest observable history of the volcanic arc. Volcaniclastic sedimentary rocks deposited by debris flow, turbidite, and grain flow processes interfinger with volcanic flows and breccia. Pillowed flows as well as massive columnar flows ranging in composition from basalt to rhyolite record interfingering episodes of submarine and subaerial deposition.

The occurrence of Reticulofenestra reticulata and Dictyococcites scrippsae in laminated siltstone and sandstone beds indicate that the rocks on Amlia are late middle Eocene to early Oligocene in age. Whole-rock radiometric ages of 32 and 39 m.y. from igneous rocks that interfinger with the sedimentary rocks corroborate the fossil ages, and are correlative in age with the Hidden Bay pluton on Adak Island.

Some of the rocks on Amlia Island are only slightly altered and contain authigenic zeolite phases, other rocks are highly altered and contain prehnite, pumpellyite, and laumontite. Areal distribution of highly altered rocks may reflect proximity to shallow-seated plutons like those that crop out on nearby Atka Island and probably underlie much of Amlia.

TABLE 1. CALCAREOUS NANNOFOSSILS (COCCOLITHS) AND PALYNOMORPHS OF AMLIA ISLAND

| Fossil assemblage | Sample locality (Fig. 2) | Age range |
|---|---|---|
| **Nannofossils (Coccoliths)** | | |
| Reticulofenestra reticulata, R. umbilica, Discolithina spp. (Fp). | 3 km N of Haystack Rock | Late middle Eocene to earlies Oligocene |
| Reticulofenestra umbilica (Fp). | 5.5 km NNW of Haystack Rock | Do. |
| Dictyococcites scrippsae Bukry and Percival (fragment), (Rp). | Cove 8 km W of triangulation station Brat | Middle Eocene to Oligocene. Sample may be contaminated |
| Reticulofenestra reticulata (Gartner and Smith) | 9 km W of triangulation station Rain | Late middle Eocene to early Oligocene |
| ? Coccolithus eopelagicus (Bramlette and Riedel), ? Cyclicargolithus floridanus (Roth and Hay) ? Discoaster barbadiensis (Specimens from 2 samples) | 16 km W of triangulation station Rain | Paleogene. Age uncertain because of poor preservation. |
| Reticulofenestra reticulata, Chiasmolithus sp. cf. C. grandis (fragment), Discolithina sp. (fragment) (Cp). | 5 km W of triangulation station Rain | Late middle Eocene? |
| Reticulofenestra umbilica. (Rp) | E shore of Hungry Bay | Late middle Eocene to early Oligocene |
| **Palynomorphs** | | |
| Picea (spruce) (2 grains), Pinus haploxylon (pine) (1 grain) Triplanosporites-Lygodium ? (1 grain) | Amlia Pass area, W end of island | (Flora too small for age determination) |

TABLE 2. WHOLE-ROCK RADIOMETRIC DATA FROM IGNEOUS ROCKS OF AMLIA ISLAND

| Rock type | Basaltic andesite (779-8-3C) | | Rhyolite (779-9-4A) | | Gabbro (779-14-25B) | |
|---|---|---|---|---|---|---|
| Sample location | 52°02.5'N 173°28.5'W | | 52°05.6'N 173°04.2'W | | 52°06'N 173°46.7'N | |
| Average $K_2O$ (%) | 1.313 | | 4.54 | | 0.35 | |
| $Ar^{40}_{rad}$ (moles/gm) | $6.00 \times 10^{-11}$ | $6.806 \times 10^{-11}$ | $2.156 \times 10^{-10}$ | $2.162 \times 10^{-10}$ | $2.076 \times 10^{-11}$ | $1.970 \times 10^{-11}$ |
| $Ar^{40}_{rad}/Ar^{40}_{total}$ | 0.69 | 0.67 | 0.91 | 0.85 | 0.66 | 0. |
| Apparent age ($10^6$ yrs) | 32.0 = ± 1.0 | | 32.7 = ± 1.0 | | 39.8 = ± 1.2 | |
| Remarks | Sample from flow rock, west side of small bay just east of triangulation station Blue, south side of Amlia Island. | | Sample from dike cutting pyroclastic rocks and conglomerate. Dike in most easterly bay along north side of Amlia Island; sample collected from west side of bay. Sample contains highest $K_2O$ of all rocks sampled. | | Relatively large area along beach with angular boulders; some boulders several meters in diameter. The outcrop that the boulders come from is not exposed but must be close by. | |

Note: Whole-rock samples were ground and sieved through 35 and 60 mesh. The samples were then washed and treated with dilute hydrofluoric acid, treated with dilute nitric acid, and placed in an ultrasonic vibrator for a short time. This method enhances radiogenic argon content and increaes precision but does not adversely affect the accuracy of the age determination.

The "±" represents estimated analytical precision based on uncertainties in the analyses of potassium and argon.

Constants used in the calculation of age were: $e + e = 0.481 \times 10^{-10}\ yr^{-1}$

$= 4.963 \times 10^{-10}\ yr^{-1}$

$\frac{K^{40}}{K_{Total}}$ $\frac{1.167 \times 10^{-4}\ mole}{mole}$

TABLE 3. THE POROSITY AND PERMEABILITY OF WELL-SORTED MEDIUM-GRAINED VOLCANICLASTIC SANDSTONES, AMLIA ISLAND

| Sample No. | Porosity (%) | Permeability (MD) |
|---|---|---|
| 779- 9-2A | 19.9 | 0.017 |
| 779-13-27 | 16.6 | 0.019 |
| 779-13-28 | 14.1 | 0.007 |
| 779-15-1A | 11.7 | 0.014 |

TABLE 4. PERCENTAGES OF TOTAL ORGANIC CARBON AND CALCIUM CARBONATE IN SEDIMENTARY ROCKS OF AMLIA ISLAND

| Sample No. | Lithology | Corrected % Carbon | | | % $CaCO_3$ |
|---|---|---|---|---|---|
| | | Total | Inorganic | Organic | |
| 779-5-2B | Sandstone | 0.62 | 0.30 | 0.33 | 2.46 |
| 779-5-2C | do | 0.85 | 0.33 | 0.53 | 2.71 |
| 779-6-1C | do | 0.69 | 0.26 | 0.43 | 2.14 |
| 779-6-1D | do | 2.23 | 1.58 | 0.65 | 13.15 |
| 779-6-1E | Siltstone | 2.42 | 1.70 | 0.73 | 14.13 |
| 779-7-2 | do | 0.80 | 0.26 | 0.54 | 2.20 |
| 779-7-4 | do | 0.85 | 0.15 | 0.70 | 1.25 |
| 779-8-1D | do | 0.66 | 0.29 | 0.37 | 2.44 |
| 779-9-1D | Sandstone | 0.55 | 0.19 | 0.36 | 1.57 |
| 779-12-2C | Siltstone | 0.70 | 0.31 | 0.40 | 2.56 |
| 779-13-1 | do | 0.67 | 0.16 | 0.52 | 1.29 |
| 779-13-2 | do | 1.19 | 0.37 | 0.83 | 3.06 |
| 779-13-6 | Sandstone | 1.12 | 0.58 | 0.54 | 4.84 |
| 779-13-25A | Mudstone | 1.65 | 1.09 | 0.56 | 9.08 |
| 779-13-25B | Sandstone | 7.44 | 6.75 | 0.69 | 56.27 |
| 779-13-25C | do | 6.45 | 6.02 | 0.43 | 50.15 |
| 779-14-3B | do | 2.59 | 2.06 | 0.53 | 17.15 |
| 779-14-3C | Siltstone | 4.34 | 3.83 | 0.51 | 31.91 |
| 779-14-5 | do | 6.75 | 6.10 | 0.65 | 50.83 |
| 779-14-25C | Sandstone | 0.91 | 0.56 | 0.35 | 4.67 |
| 779-14-26A | do | 0.55 | 0.17 | 0.38 | 1.39 |
| 779-15-1A | Siltstone | 0.56 | 0.18 | 0.39 | 1.46 |
| 779-15-1B | do | 0.77 | 0.34 | 0.43 | 2.86 |

TABLE 5. MAJOR-ELEMENT CHEMISTRY OF TYPICAL IGNEOUS ROCKS FROM AMLIA ISLAND DETERMINED BY X-RAY FLUORESCENCE AND PARTIAL CHEMISTRY TECHNIQUES

(Rock names from classification of Irvine and Baragar, 1971)

| Oxide | Basalt (779-7-6B) | Gabbro (779-11-2) | Basaltic andesite (779-6-4) | Andesite (779-6-3C) | Tonalite (779-8-2B) | Rhyolite (779-11-6A) |
|---|---|---|---|---|---|---|
| $SiO_2$ | 47.14 | 50.05 | 52.81 | 60.47 | 64.28 | 70.00 |
| $TiO_2$ | 1.01 | 0.95 | 1.10 | 0.89 | 0.76 | 0.64 |
| $Al_2O_3$ | 17.34 | 19.62 | 16.57 | 15.54 | 15.34 | 13.21 |
| $Fe_2O_3$ | 6.92 | 3.81 | 3.05 | 3.11 | 2.87 | 2.86 |
| FeO | 4.24 | 5.18 | 4.34 | 4.80 | 2.92 | 1.41 |
| MnO | 0.24 | 0.12 | 0.14 | 0.12 | 0.13 | 0.08 |
| MgO | 5.39 | 3.70 | 4.49 | 3.20 | 1.70 | 1.24 |
| CaO | 10.96 | 10.41 | 5.41 | 3.77 | 2.32 | 1.46 |
| $Na_2O$ | 3.22 | 3.60 | 4.41 | 4.78 | 4.92 | 4.66 |
| $K_2O$ | 0.27 | 0.68 | 3.02 | 2.21 | 2.52 | 1.93 |
| $P_2O_5$ | 0.18 | 0.17 | 0.23 | 0.25 | 0.24 | 0.13 |
| $H_2O^+$ | 0.83 | 1.86 | 2.83 | 1.49 | 1.16 | 1.20 |
| $H_2O^-$ | 3.36 | 0.45 | 1.14 | 0.75 | 0.83 | 0.55 |
| $CO_2$ | 0.20 | 0.08 | 0.05 | 0.10 | 0.06 | 0.04 |
| Total | 101.30 | 100.68 | 99.59 | 101.48 | 100.05 | 99.41 |

TABLE 6. CHEMICAL COMPOSITION OF ROCKS CONTAINING HIGH CONCENTRATIONS OF SECONDARY MINERALS, AMLIA ISLAND

(Major oxides of all minerals except prehnite determined by x-ray fluorescence; prehnite determined by emission spectroscopy and calcium of the prehnite by atomic adsorption. Minor elements determined by emission spectroscopy. Numbers with symbols are the limits of detection for phase respective elements. -- means interference. LOI is Loss on ignition at 900°C. Thomsonite: 90-95% thomsonite, 1-5% mesalite (?), and 1-4% plagioclase. Analcime: 90-95% analcime, 2% smectite, 2% chlorite, 2% plagioclase, and <1% laumontite. Heulandite: 75% heulandite, 25% quartz, and 1-2% smectite. Laumontite: 100% laumontite. Prehnite: 98-99% prehnite, and 1-2% laumontite.)

| | Thomsonite[1] (779-13-4B) | Analcime[2] (779-13-28) | Heulandite[3] (779-14-26A) | Laumontite[4] (779-14-27B) | Prehnite[5]* (779-14-27) |
|---|---|---|---|---|---|
| | | | Oxides (%) | | |
| $SiO_2$ | 46.9 | 47.0 | 58.6 | 54.0 | 44.9 |
| $TiO_2$ | <0.02 | 0.99 | 0.49 | <0.05 | <0.03 |
| $Al_2O_3$ | 20.5 | 16.5 | 12.7 | 19.7 | 17.4 |
| $Fe_2O_3$ | 0.03 | 10.1 | 3.91 | 0.35 | 2.72 |
| MgO | 0.1 | 4.3 | 1.4 | 0.3 | <.17 |
| CaO | 13.8 | 5.05 | 6.07 | 11.6 | -- |
| $Na_2O$ | 3.7 | 6.1 | 0.7 | <0.5 | <0.2 |
| $K_2O$ | 1.18 | 0.58 | 0.24 | 0.06 | 0.10 |
| $P_2O_5$ | <0.1 | 0.1 | 0.2 | <0.3 | <0.05 |
| LOI | 14.5 | 9.75 | 14.6 | 13.2 | -- |
| Total | 100.71 | 100.47 | 98.91 | 99.21 | -- |
| | | | Elements (ppm) | | |
| Mn | <150 | 1781 | 150 | <387 | <200 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| * Ag | <1 | Ce | <100 | La | <20 | Pb | 18 | Y | <10 |
| B | <10 | Co | 3.6 | Li | <50 | Sc | <10 | Zn | -- |
| Ba | 29 | Cr | <10 | Mo | <10 | Sn | <10 | Zr | 28 |
| Be | <1 | Cu | 15 | Nb | <25 | Sr | <10 | | |
| Cd | <2 | Ga | 76 | Ni | 4.4 | V | 41 | | |