Geology

Axes of elongation of petrified stumps in growth position as possible indicators of paleosouth, Alaska Peninsula

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Axes of elongation of petrified stumps in growth position as possible indicators of paleosouth, Alaska Peninsula

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ABSTRACT

Tertiary petrified forests at Kujulik Bay and Unga Island, Alaska Peninsula, show that growth rings in individual petrified stumps are thicker on one side of the stumps than the other, as do recent trees. Explanations for preferential growth of tree rings include (1) direction of prevailing winds, (2) downslope direction, and (3) direction of prevailing sunlight. The third explanation is considered most plausible for the Kujulik Bay and Unga Island petrified forests. Because these forests lived in the Northern Hemisphere, their directions of prevailing sunlight (and therefore preferential growth) should have been to their paleosouth. As such, the petrified forests at Kujulik Bay (late Eocene to early Oligocene) and Unga Island (late Miocene) suggest paleosouth was located, respectively, to S38 ± 14°W and S44 ± 15°W.

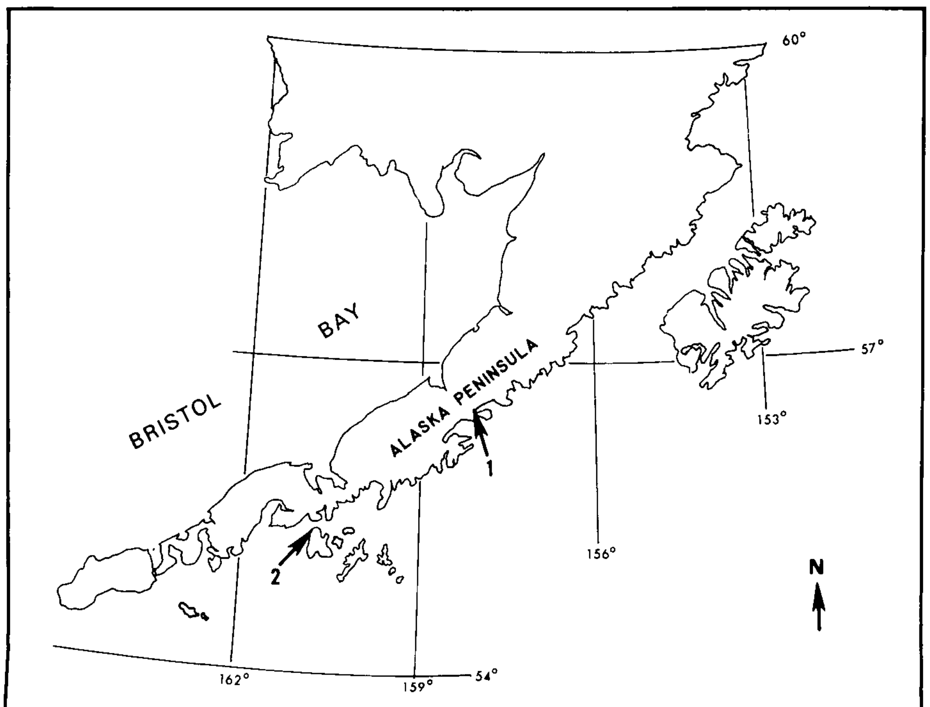

Figure 1. Locations of petrified forests: 1, Kujulik Bay; 2, north Unga Island.

GEOLOGIC SETTING

The geography of the Alaska Peninsula during much of Tertiary time was similar to the present; andesitic volcanoes supply volcanic products to nearby fluvial and shallow marine environments (Burk, 1965). Our work on the Alaska Peninsula during 1977 and 1978 suggests that episodes of widespread volcanism occurred from middle Eocene to early Oligocene and from late Miocene to the present. Both petrified forests studied (Fig. 1) were engulfed by coarse andesitic lahar deposits, one of late Eocene to early Oligocene age (Meshik Formation of Kujulik Bay) and one of late Miocene age (Unga Conglomerate of Unga Island).

PETRIFIED FORESTS

Kujulik Bay

The Meshik Formation in the Kujulik Bay area consists of gently dipping beds (<10°) of subareal agglomerate, lava flows, and volcanic sandstone. No fossils other than petrified trees occur in this area, but samples of andesite yielded K-Ar hornblende ages of 42.2 ± 3.0, 35.0 ± 2.8, and 33.1 ± 1.8 m.y. (approximately late Eocene to early Oligocene). A petrified forest engulfed by agglomerate is exposed along the seacliff at the west end of Kujulik Bay (Fig. 1). Individual stumps stand nearly perpendicular to bedding; this indicates that the stumps grew on a nearly horizontal surface. Orientations of 14 axes of elongation of oval horizontal cuts of the stumps in near-vertical living positions

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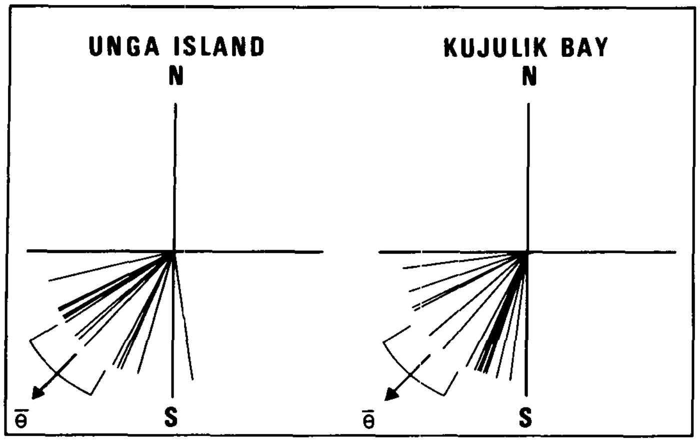

	NO. OF MEASURE-MENTS (N)	VECTOR MEAN ($\bar{\theta}$)	LENGTH OF VECTOR MEAN (r)	ANGULAR STANDARD DEVIATION AROUND VECTOR MEAN (S)	95% CONFIDENCE INTERVAL AROUND VECTOR MEAN (α_{95})
UNGA ISLAND	14	S44°E	12.9	±23°	±14°
KUJULIK BAY	14	S38°E	12.8	±24°	±15°

Figure 2. Orientations of axes of elongation of oval horizontal cross sections of petrified stumps in vertical living positions. Summary of vector mean, standard deviation, and confidence interval calculated by standard techniques as outlined in Batschelet (1965).

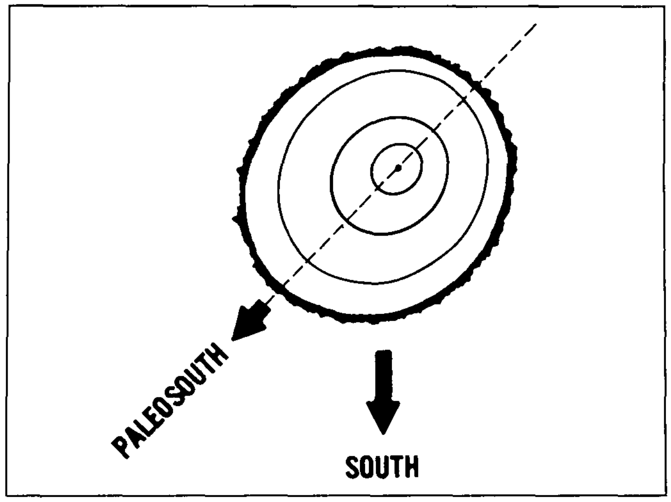

Figure 3. Diagrammatic horizontal cut of petrified stump showing direction of preferential growth (paleosouth) and direction of present south.

are plotted in Figure 2. The horizontal cuts generally display distinct preferential growth in the southwest direction of elongation as diagrammatically shown in Figure 3. The stumps show no signs of deformation from clasts in the agglomerate that engulfs them.

Unga Island

The Unga Conglomerate at north Unga Island consists of nearly flat-lying beds of subareal agglomerate and volcanic sandstone with some siltstone and coal. Palynology studies indicate that these beds are late Miocene in age. A petrified sequoia forest engulfed by agglomerate is exposed along the seacliff at north Unga Island (Eakins, 1970; Fig. 1). Individual stumps are oriented approximately normal to bedding; this indicates that they grew on near-level surfaces. Measurements taken on 14 stumps are plotted in Figure 2. The stumps and bedding show no signs of deformation.

DISCUSSION

Studies of modern trees growing at relatively high latitudes on level surfaces are necessary in order to confirm that their elongation axes trend toward geographical south. If recent elongation axes do trend approximately south, then we may speculate that elongation axes of petrified stumps in growth position trend to their paleosouth.

Audrey Wright at the University of California at Santa Cruz conducted a preliminary study of the axes of elongation of redwood tree stumps near Crescent City, California. She made 19 measurements of stumps that grew on flat terrain and found that 14 of them were elongated within 30° of south (vector mean = 178.4°, angular standard deviation around vector mean = 38.6°).

The elongation axes of the stumps from the two areas (and ages) show a remarkable coincidence (Fig. 2). At the 95% confidence level the mean directions are not distinguishable from each other but are significantly different from the present south direction. Thus, these data suggest little rotation of the Alaska Peninsula from late Eocene–early Oligocene to late Miocene, but it has rotated about 45° since. More localities and measurements are needed to verify and expand (or reject) these tentative conclusions. We therefore present this paper principally as a possible technique for determining paleosouth, not as a definitive rotational history of the Alaska Peninsula. It is noteworthy that these results are comparable to paleomagnetic determinations of paleonorth (Stone and Packer, 1979).

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