

tal shelf. These units, defined on the basis of seismic reflection and sedimentologic data, are (1) Holocene glacial-marine sediments, (2) Holocene end moraine deposits, (3) Holocene (neoglacal) and Pleistocene glacial sediments, and (4) Pleistocene and older lithified sedimentary rocks. Each of these four units is divisible into facies on the basis of depositional environment. Each of the units was derived either totally or in part as a result of glaciation, hence each unit is a chronofacies or lithofacies of the overall glacial and glacial-marine depositional picture of the northeast Gulf of Alaska during the Quaternary.

The Holocene glacial-marine sedimentary unit contains sediment originally glacially eroded and transported that was (and is) deposited in the marine environment through glacial-fluvial, eolian, or ice-transported mechanisms. Facies in this unit vary from unimodal clayey silt to bimodal pebbly silt and clay with large percentages of ice-rafted components. The end moraine unit, which contains deposits representing the farthest penetration onto the shelf of fiord-filling piedmont and valley glaciers, contains facies ranging from massive boulder and cobble accumulations to fine-grained silt and clay that accumulated in basins within the lobes of the moraine. The Holocene (neoglacal) and Pleistocene sedimentary unit is the most variable of the four units as it contains sediment ranging from multi-modal ablation and lodgment tills, to recessional glacial-lacustrine and outwash facies, to marine pebbly mud. Post-depositional winnowing has further modified the textural and compositional nature of this unit.

The lithified sedimentary rock unit, typified by submarine outcrops of the Yakataga Formation, contains components of each of the three other units. The lithified unit, however, represents glacial and glacial marine events predating Holocene time. Stratigraphic and paleontological evidence suggests that the depositional environments producing the facies present in the Quaternary sedimentary units have changed little since middle Miocene time, and the influence of glaciation has been the primary controlling factor in the shaping of upper Tertiary and Quaternary depositional sequences.

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Lacustrine, Fluvial, and Fan Sedimentation—Quaternary Climate Change and Tectonism, Pine Valley, Nevada

Pine Valley, an intermontane graben in the Basin and Range province, has trapped a unique record of Quaternary volcanoclastic fluvial-lacustrine sediments, largely exposed by late Pleistocene tectonism and erosion. These are analogous to Great Basin sediments spanning the Tertiary and which produce oil in Railroad Valley, Nevada, and Rozel Point, Utah, and gas in Carson Sink, Nevada.

Three major facies in the 400+-m thick middle Pliocene to middle Pleistocene Hay Ranch formation are shallow lacustrine, fluvial, and alluvial fan. Deposits from the fresh-water, quiet, alkaline, oxygenated lakes include tuffaceous calcilutite interlayered with rhyolitic vitric tuff, zeolite, silt, and clay. Organic content varies widely. Grading laterally and in places vertically are

fluvial lithofacies of thickening wedges of silt and sandstone. Sedimentary structures indicate episodic transport by anastomosing stream channels and spreading sheetflood, which grade into sand to cobble-fan-glomerates of valley-margin alluvial fan facies and include water-lain and debris-flow clasts.

Middle Pleistocene to Holocene sediments are of unconsolidated fluvial and alluvial fan facies, with minor landslide, talus, and thin carbonate lake and welded tuff facies.

The complexly interfingering facies and subfacies represent transgressing and regressing lake shorelines and variable fluvial input related to glacial climatic changes and are best illustrated with a series of time-sequential basin facies maps. Decreased evaporation and increased precipitation during glacial times, at least in winter, pulsed clastics to narrow basin-margin fans, and clay and silt to the lake center. Dry periods allowed thicker algal lime mud and ash to accumulate. Lack of paleosols, beaches, paludal facies, and lake shallowness preclude very wet conditions.

Tectonism had a steady control on sedimentation. Growing horst relief maintained local stream gradients. Pleistocene epeirogenic uplift and tilting northward of the region reversed the flow of and entrenched Pine Creek; the new external drainage dissected Hay Ranch pediments and inhibited playa evaporite and perhaps beach deposition and preservation. Continued extension and slight south and east tilting of the graben, however, roughly kept pace with warping during Hay Ranch time.

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Benthic Foraminifers From Eastern Gulf of Alaska

Grab samples, dart cores, and gravity cores from the Gulf of Alaska between Montague Island and Yakutat Bay were analyzed for benthic foraminifers. Robust specimens of *Cassidulina californica*, *C. limbata*, and *Cibicides lobatulus* are abundant in coarse sediment on Tarr Bank, Middleton Island platform, and along much of the outer shelf east of Kayak Island. This fauna may be relict, as it occurs in areas known from seismic profiles to be nearly devoid of the Holocene clayey silt which blankets much of the shelf. In several samples, glauconite associated with this fauna provides evidence for a low rate of sedimentation.

Another fauna, in which *Epistominella pacifica* occurs with *Elphidium clavatum* (typically a shallow-water, inner-shelf species), is found in Kayak Trough at depths ranging from 146 to 234 m and in Hinchinbrook Sea Valley at 205 m. Both of these depressions have topographic highs at their seaward terminations. In previous studies in other parts of the Gulf of Alaska, *Epistominella pacifica* is reported to be common above 300 m depth; however, farther south, off California, Oregon, and Washington, *E. pacifica* usually occurs at depths greater than 300 m. The association of *E. pacifica* and *Elphidium clavatum* might therefore be useful in determining paleoenvironments; their co-occurrence could indicate a depression, such as a trough or sea valley, somewhat restricted from open sea conditions.