offshore flow. In the absence of strong coastal currents, the net water drift along the sea floor may be either toward or away from the beach, and it is influenced by the wave climate, tidal flux, wind, and internal waves. Research currently is in progress to determine the relation of hydrodynamic parameters to directions of sediment migration.

Rip currents also are important agents of sediment transport on the inner continental shelf and they have been studied in the Los Angeles area. Their development is influenced by wave climate, beach morphology, tidal level, and wind. Large rip currents carry significant quantities of sediment seaward. Rips of all sizes winnow fine-grained, low-density sand from the surf zone and thereby concentrate coarse grains and heavy minerals on the beach. The sand transported by rip currents settles to the sea floor beyond the breakers where it is influenced by wave-generated surge.

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Computer Simulation of Nearshore Sediment Transport

Can a heterogeneous mixture of sediment grains of various sizes and specific-gravity values be partitioned effectively into relatively homogenous sedimentary groups by diffusion processes in nearshore areas? If so, where will concentrations of heavy minerals occur, and what will be the relation between mineral concentrations and subaqueous topography, assuming constant wave conditions? A computer simulation model is used to explore these questions. Components of the model include: (1) a rectangular gridwork of cells, which is used to subdivide the region of interest, and provides the framework of an accounting system for keeping track of sediment movement, changes in bottom topography, wave energy and orbital velocities; (2) a wave-refraction algorithm, modified from Dobson which traces wave rays (calculating wave heights at intervals) from deep-water offshore into the shallow-water breaker zone; and (3) a sediment transport algorithm, which uses a two-dimensional diffusion equation with isotropic diffusion coefficients. Diffusion rates may be changed by altering the diffusion coefficients, which are here assumed to be a function of wave energy, grain size, and specific gravity.

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A "Semipro" Revisits Middle Tertiary Foraminiferal Sequence of California Coast Ranges

(No abstract submitted)

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Lineage Genera Classification of Lower Paleogene Planktonic Foraminifera

Current classifications of planktonic Foraminifera rely on rigid structural hierarchies, defining genera as narrow morphologic entities, commonly with long and discontinuous ranges. Such classifications do not satisfy the criteria of either monophyly or practicality. More properly, genera are based on phyletic successions of species through time, thus creating natural (Linnaean), monophyletic, and stratigraphically restricted taxa. Lower Paleocene species are here reclassified into five lineage-genera. These genera partly overlap in gross morphology and in certain iteratively developed analogous structures, but possess adequate diagnostic features (especially wall texture) for recognition.

All presently recognized Paleocene lineages except the chiloguembelinids (including *Globoconusa*) are derived from the early Danian species "*Globorotalia*" *pseudobulloides*, and become sufficiently divergent for generic distinction by late Danian time. This species is derived from, and congeneric with, "*Hedbergella*" *monmouthensis*.

Globanomalina includes smooth-walled, compressed, globorotaloid forms with slit-like extraumbilical apertures; finely perforate peripheral rims (keels) occur in two species. Morphotypes transitional with the Eocene planispiral genus *Pseudohastigerina* occur in the uppermost Paleocene and are best interpreted to be part of the reaction range of *Globanomalina chapmani*. *Subbotina* includes globigerinid forms with pitted, coarsely perforate (reticulate) walls; late middle Eocene populations gave rise to the predominantly Neogene genera *Globorotaloides* and *Catapsydrax*.

An innovation critical for phylogeny was the development of coarsely hispid wall surfaces, which first appeared in neanic chambers of the early Danian form, "*Globorotalia*" *pseudobulloides praecursoria*. Intensification and persistence into adult chambers of hispid ornamentation accompanied the transition of "*G.*" *pseudobulloides praecursoria* to "*Globorotalia*" *inconstans* in middle Danian time. "*G.*" *inconstans* is the phyletic base for two isochronous radiations characterized by densely hispid wall surfaces.

Acarinina includes globigerinid forms with rounded chambers and umbilical to extraumbilical primary apertures. Dorsal sutural apertures appear in two middle Eocene species (*Truncorotaloides* of authors); these forms, however, are phyletic "dead-ends" and are not here afforded generic recognition. *Morozovella* includes globorotaloid forms with conicotruncate chambers and peripheral concentrations of somewhat elongate rugosities (keels). Both radiations diverge into several disparate lineages. Poorly understood problems of intense parallelism and isomorphism preclude for the present more refined delineation of phylogenies.

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Planktonic Foraminiferal Indices Common to Lower Pliocene of Southern California and Italy

Five planktonic foraminiferal relations common to the lower Pliocene marine record of Italy and southern California are: (1) "*Sphaeroidinellopsis*" has an upper limit within or near the top of the lower Pliocene; (2) "*Sphaeroidinella dehiscens*" (Parker and Jones) makes its first appearance within or at the base of the lower Pliocene; (3) *Globigerina woodi decoraperta* Takayanagi and Saito extends through the lower Pliocene into the middle Pliocene; (4) rare specimens referable to *Turborotalia globorotaloidea* (Colom), a typical upper Miocene species, continue to occur in the lower Pliocene; and (5) *Turborotalia puncticulata* (d'Orbigny) appears to be restricted to the lower Pliocene in both areas.

Differences between the lower Pliocene planktonic foraminiferal ranges of Italy and southern California include: (1) appearance of *Globorotalia crassaformis* Galloway and Wissler in the lower Pliocene of California whereas it does not appear until the middle Pliocene in Italy; (2) *Turborotalia inflata* (d'Orbigny) first appears as a rare member of *T. puncticulata* populations in the lower Pliocene of southern California whereas it first appears in the upper Pliocene of Italy; and (3) *Globigerina pachyderma* (Ehrenberg) occurs in the lower Pliocene of both areas; it is dextrally coiled in southern California and probably is dextral in Italy as well.

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Foraminiferal Trends in Oregon Sublittoral

Benthic foraminiferal species from a part of the central Oregon shelf are grouped into four distinct bathymetric faunas. *Elphidiella hannai* and *Buccella* spp. are indicative of Fauna A (17–50 m). Fauna B (50–100 m) is characterized by *Buliminella elegantissima* and *Elphidium magellanicum*. In the rocky area off Cape Arago *Cassidulina californica, C. limbata, Cibicides fletcheri,* and *C. lobatulus* become dominant. *Spiroplectammina biformis, Textularia earlandi,* and *Trifarina angulosa* are important species of Fauna C (100–175 m). Abundant species of Fauna D (175–339 m) include *Eggerella advena, Epistominella exigua,* and *Uvigerina juncea.*

Species diversity increases offshore to a maximum of about 35 benthic species near 100 m and then decreases slightly with depth. The standing crop is small nearshore, increases to a maximum of approximately 300 specimens per 20 cm^3 between 125 and 150 m, and then declines. The total benthic population reaches a maximum of approximately 6,000 specimens per sample between depths of 150 and 175 m. Values then decrease to about 2,000 specimens at 339 m. A maximum of 15–20 percent live benthic specimens occurs near 50 m. Planktonic Foraminifera normally constitute less than 10 percent of the total population. Maximum percentages generally are in water shallower than 100 m, whereas maximum specimens per sample are at the deepest stations. Porcelaneous specimens do not exceed 6 percent of the benthic population. Agglutinated Foraminifera are more abundant than calcareous specimens at depths greater than 100 m.

Miscellaneous biofacies trends indicate that: thecameobians are most abundant between 50 and 125 m; statoliths and otoliths are most abundant between 75 and 200 m; the largest number of ostracods are between 25 and 150 m; and radiolarians generally predominate over Foraminifera below 250 m.

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Distribution of Foraminifera on Alaskan and Siberian Continental Shelves

Through the greater part of the inner sublittoral zone of the Alaskan and Siberian shelves, the foraminiferal fauna is dominated by species with an arenaceous test wall. Species are few and generally one species is overwhelmingly dominant, but the dominant species is different from one area to the next as a result of changes in the oceanographic regime.

Oceanographic conditions in the Chukchi Sea are dominated by northward flow of water from the Bering Sea through Bering Strait. In both seas adjacent to the coast of Alaska the water is warmer and less saline and *Eggerella advena* is dominant in bottom sediments. Farther offshore in both seas *Reophax arctica* is dominant. Dominance by these two species extends northward to the limits of the permanent ice pack beyond which *Textularia torquata* is dominant on the Siberian shelf and *Spiroplectammina biformis* on the Alaskan shelf. High relative frequencies of *S. biformis* also characterize the Gulf of Anadyr where very cold bottom waters persist all year.

Two calcareous faunas exist. An *Elphidium clavatum*-dominated fauna is associated with deltaic environments or more polar shelf environments. The other calcareous fauna has a greater diversity, especially in *Elphidium* spp. and *Buccella* spp., and generally is associated with coarser grained sediment in straits and nearshore areas. This latter calcareous fauna may represent, in part, reworked or relict faunas.

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Secondary Calcification in *Globorotalia Menardii* (Foraminiferida)

Specimens of the planktonic foraminifer *Globorotalia menardii* (Parker, Jones, and Brady) were examined in bottom samples from three profiles across the continental shelf and slope of the South China Sea. This species is absent in inner shelf assemblages; middle-shelf populations of *G. menardii* are dominated by forms with tests characterized by smooth, thin, translucent walls and unthickened keels (*G. "cultrata"* of authors). Specimens with coarsely crystalline crust covering much of the test wall and keel become increasingly common seaward, although the distribution of crust-bearing forms on the outer shelf is irregular because of current transport. The percentage of incrusted tests in bottom sediments reaches values of 80–100 just beyond the shelf edge (180–275 m), and these values are maintained across most of the continental slope. A narrow zone of high percentages of noncrusted forms occurs in all three profiles on the upper continental slope at depths of 275–500 m; these deposits represent concentrations of small tests swept off the shelf.

Young specimens of *G. menardii* live at relatively shallow depths. By the early adult stage of development, the individual organisms descend in the water column where they continue to grow. At increased depth, development of a secondary crystalline crust begins, first with thickening of the keel and then with incrustation on both dorsal and ventral walls. Secondary calcification on the exterior walls of the last chamber, including the apertural face, is represented by thickening and increased opacity of the wall without the development of a typical crust. Because chambers are added after the onset of crust formation, the lack of secondary calcification on septa and on the ventral walls of chambers enclosed within the last whorl of the test indicates that previously secreted crystalline crust has been resorbed.

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Size-Depth Variation in Foraminifer *Cyclammina Cancellata* Brady from Peru-Chile Trench Area