center lobby of subsurface interpretation, each of our two professions has built an extensive network of specialized branch structures between which there are few connecting hallways. We have in the oil industry, however, just one large building and if the geophysicists set fire to their end, your end will burn, and vice versa. If one group makes improvement in its part of the structure, the equity of the other group is equally enhanced, but no great stride forward will be possible until the whole structure is modernized.

The greatest weakness in our common structure is our lack of control of the basic plan. We geologists and geophysicists have been so engrossed in scientific endeavor, in gloating over our successes, or in crying over our failures, that we have abandoned exploration planning. We have shoved aside this responsibility and left it to the accountants, the bankers, the mathematicians, the graduates of the School of Business Administration, or to conclusions drawn from data fed to electronic computers. Consequently we should not be surprised to find exploration programs defined now in terms of dollars instead of ideas, budget allocations determined by the size of the district office staff instead of program merit, and that a "deal" submitted by an outsider is more attractive to management than our own program because the outsider's deal can be fitted neatly into a fixed quarterly budget.

If we want a better building, then we must help design it. We may even be surprised to find that management will welcome our help.

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SILURIAN AND DEVONIAN ARENITES OF THE FRANKLINIAN EUGEOSYNCLINE

The Franklinian eugeosyncline, mobile from the late Precambrian or Cambrian to the late Devonian or early Mississippian, is exposed mainly in northernmost Axel Heiberg and Ellesmere Islands. The Silurian and Devonian arenites consist of the following genetic groups:

1) Lower Silurian calcareous lithic arenite: post-tectonic marine shelf deposits produced by Ordovician(?) uplift of metamorphosed limestone off northern Ellesmere Island.
2a) Late Middle and early Upper Silurian lithic and volcanic, partly graded arenites: early syntectonic deposits, related to Caledonian movements, composed of sediments as in (1) with contemporaneous keratophyric pyroclastics.
2b) Upper Silurian and Devonian quartz-chert arenites: marine and nonmarine syntectonic and post-tectonic sediments, produced by Caledonian uplift of quartzose sandstone, chert, etc., with some contemporaneous pyroclastics in the upper part.
3) Devonian graded volcanic arenites: early syntectonic turbidites related to a major late Devonian orogeny derived from Silurian keratophyric rocks, to contemporaneous volcanism, or both.

Most of the inferred source rocks seem to have recognizable equivalents in the pre-Devonian (mainly pre-Ordovician) eugeosynclinal succession. The Silurian and Devonian arenites, then, originated partly by contemporaneous pyroclastic volcanism but mainly by uplift, erosion, and rapid redeposition of strata deposited earlier in the mobile belt itself. Turbidity current deposition seems to be confined to syntectonic phases. Sandstones with more than 10% of clay matrix are relatively sparse.

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ORIGIN OF SODIUM-RICH TRIASSIC LACUSTRINE DEPOSITS, NEW JERSEY AND PENNSYLVANIA

Successive Stockton arkose, Lockatong argillite, and Brunswick mudstone, nonmarine basin deposits, contain abundant sodium derived from Na-feldspar-rich source rocks that lay to the east.

Lockatong lacustrine deposits (3,750 feet thick), in cycles averaging 15 feet thick, accumulated at a rate of about 0.2 mm. a year. Detrital cycles consist mainly of mudstone containing abundant Na-feldspar, illite (and muscovite) and chlorite, and calcite, but very little quartz or K-feldspar. They are composed of abundant Na_2O (4.0%), K_2O (5.2%), and MgO (3.8%), and only about 49 per cent SiO_2. They accumulated in an open lake with estimated low salinity, Eh 0 to -2.5, and pH 7 to 8.

Chemical cycles consist mainly of colloidal-chemical mudstone containing abundant analcime, Na-feldspar, dolomite and calcite, and illite and chlorite; quartz is absent and K-feldspar is very rare. The rock is composed of K_2O (3.3%), abundant MgO (4.0%), very abundant Na_2O (6.4%), and only 49 per cent SiO_2. Cr, V, Ni, and Co approach or exceed concentrations in marine mud. These cycles accumulated when the lake was closed; gray deposits in an environment of estimated moderate salinity, Eh -1 to -3, and pH 7.5 to 8.5, and grayish-red deposits in an environment of somewhat higher salinity, Eh -0.5 to 1.5, and pH 7.0–8.5.

Lockatong detrital and chemical cycles shared a common physical (lacustrine) environment. But detrital cycles and fine-grained Stockton fluvial facies shared a rather similar geochemical environment, as did chemical cycles and lowermost Brunswick mudflat facies.

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SUBMARINE FAN DEPOSITS AND THE TRANSITION FROM TURBIDITE TO SHALLOW WATER SEDIMENTS IN THE UPPER CARBONIFEROUS OF NORTHERN ENGLAND

The Shale Grit and Grindslow Shales lie between the Mam Tor Sandstones (turbidites) and the Kinderscout Grit (nearshore or coastal plain sediments). These Upper Carboniferous formations crop out in the central Pennine Basin of northern England. The Shale Grit contains two main sandstone facies: (1) interbedded parallel sided sandstones and mudstones interpreted as turbidites and (2) thick (5 to 100 feet) sandstones without mudstone partings interpreted as very proximal turbidites. Individual thick beds characteristically show signs of a multiple origin. There are also three mudstone facies, silty mudstones, pebbly mudstones, and thinly laminated black mudstones. The Grindslow Shales contain sandy mudstones, burrowed silty mudstones, parallel bedded silty sandstones and carbonaceous sandstones. There are also some horizons of normal and proximal turbidites, especially near the base of the formation.

The sequence of the Shale Grit facies indicates that distal turbidites are more abundant below, and proximal turbidites are more abundant in the upper part of the formation. In the Grindslow Shales the facies become sandier upward, with horizontal burrows restricted to the uppermost part of the formation. The two formations contain at least seventeen deep channels (10 to 50 feet), which appear to have been both cut and filled by turbidity currents. The association of deep channels and proximal turbidite sedimentation suggests that the environment of deposition of the Shale Grit was a submarine fan, similar in most respects to the fans at the foot of the Monterey and La Jolla canyons. The Grindslow Shales were probably deposited on the slope above the fan.

The sequence from the Mam Tor Sandstones (distal turbidites) via the lower Shale Grit (distal, with subordinate proximal turbidites) into the upper Shale Grit (proximal, with subordinate distal turbidites) suggests advance of a submarine fan into the central Pennine Basin. The advance continued as the Grindslow Shales slope environment covered the fan, and was itself covered by the nearshore or coastal plain Kinderscout Grit.

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Late Paleozoic Deltas in the Central and Eastern United States

Environmental mapping in Pennsylvanian and Mississippian rocks from Oklahoma to Pennsylvania has shown that most lenticular masses of sandstone and shale are parts of deltaic complexes. In Late Mississippian and Pennsylvanian rocks, deltaic expansion commonly follows brief marine transgressions. Widespread marine limestones may terminate against broad arcs of prodeltas composed of evenly laminated gray shales with ironstone nodules. The prodelta deposits become more sandy upward and are succeeded by conformable sheet sands or unconformable lenticular sandstones. Thicknesses of the combined delta and prodelta deposits in eastern and central United States are as much as 150 feet, composed entirely of shale, or sandstone or both.

Source areas for delta sands are north, east, and southeast of the Appalachian basin; northeast and north of the Illinois basin and northern Mid-continent; and south, southeast, and southwest of Oklahoma. The Ozark uplift, Nemaha ridge, and central Kansas uplift were unimportant sources; the Canadian shield, northern Appalachians, Transcontinental arch, and Ouachita and Arbuckle uplifts were principal sources. Deltaic growth from different directions was not contemporary.

Detailed mapping of minor features of these deltas, now in progress, shows intricate patterns of sand and shale and indicates that surface configuration of a delta is an important determinant of distribution and thickness of Pennsylvanian coals. Four deltas have been studied in the Lower Mississippian (Pepper and Dewitt), twelve in the Upper Mississippian (Swann and Potter), and twenty in the Pennsylvanian. Examples of entire deltas and details of portions of deltas are illustrated.

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The Stratigraphy and Sedimentary Petrology of Miocene Turbidites in the San Joaquin Valley

A thick Miocene marine basinal succession, dominantly sandstone, underlies the southern portion of California's San Joaquin Valley. Deposited in paleontologically defined depths of as much as 5,000 to 6,000 feet, the sands are pebbly and gritty to fine grained, largely angular, poorly sorted, often silty and micaceous, quartzose to arkosic and are interbedded with dark carbonaceous shales. Graded bedding is common and in conjunction with depth estimates is taken to imply turbidity current origin for most of the sands.

Early Miocene turbidites spread far southwestward from the Sierra Nevada provenance, but by late Miocene, anticlinal barriers, rising from the sea floor, restricted the turbidites, including the highly productive Stevens sands, to the northeastern side of the basin. These late Miocene sands at first entered from discrete troughs or canyons but later from more widely dispersed sources as shelf sands encroached. Deep basinal transport seems to have been axially northwestward. Locally, thick Stevens synclinal channel sands spread eastward off the rising Temblor Range. Sudden cessation of basinal sand deposition was followed by deposition of chert, shale, and Pliocene neritic sediments.

Detailed subsurface correlations show that Stevens sand bodies include sinuous channel fills bounded by major anticlines, sands flanking and covering lower structures, and lobate and branching apron sands in simple homoclinal areas. Compaction structures are shown to control some accumulations and offer clues for continuing exploration.

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Chemical Composition of Siderite Nodules in the Environmental Classification of Shales

In the search for geochemical indicators for the environmental classification of non-fossiliferous, clastic sedimentary rocks, the chemical composition of 45 syngenetic "siderite nodules" from shales of Pennsylvanian age was investigated. Nodules were assigned to three categories on the basis of closely associated fossils: (1) FW—freshwater (*Estheria*, *Leaia*, *Anthraconauta*, *Carbonicula*), (2) B—brackish, restricted marine or nearshore marine (*Lingula*, *Orbiculoidea*, *Dunbarella*, *Aviculopecten*), and (3) M—marine (*Chonetes*, *Mesolobus*, etc.). Of 11 elements determined, Si, Al, Mg, Ca, Ba, and V are useful as environmental discriminators. Means (and standard deviations) of these elements by category are as follows:

	% SiO_2	% Al_2O_3	% MgO	% CaO	% Ba	% V
FW	30.75 (12.8)	13.42 (7.25)	2.22 (.674)	2.55 (2.17)	.0360 (.0118)	.0094 (.0039)
B	13.67 (7.44)	5.77 (3.95)	2.47 (1.32)	2.97 (.824)	.0180 (.0110)	.0110 (.0042)
M	11.56 (3.25)	4.84 (1.12)	3.58 (1.02)	5.81 (1.66)	.0140 (.0033)	.0140 (.0043)

A three-group, six-variable discriminant permits complete separation of individual FW and M samples, but is less successful in distinguishing the brackish and restricted marine shales as a separate category. Siderites forming during sedimentation may prove especially useful for environmental discrimination where variations in the detrital to authigenic clay mineral ratio diminish the value of trace element indicators in the argillaceous fraction of the rock.

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O^{18}—O^{16} Ratios of Evaporitic Dolomite From the