A comparison between actual flow-inducing pressure gradients in an aquifer and other representations of water potentials, such as h_w, indicates possible errors in depiction of flow rate and direction by the latter. By disregarding ground-water density variations, in some methods of analysis, we can seriously misinterpret hydrodynamic phenomena.

When the flowing pressure forces in an aquifer are known, it is a simple matter to derive oil potentials in terms of these new quantities. This is done in essentially the same manner as shown by Hubbert in 1953. The mapping of flow-inducing pressure gradients provides us with a simpler and more accurate way of describing dynamic ground-water systems.

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Internal Structure of Massive Sandstones

The structure of 306 samples of seemingly homogeneous massive sandstone from 74 formations was studied by use of radiography. This technique consists of placing a large thin slice of rock directly upon photographic film and exposing it to an X-ray source from a standard medical or industrial X-ray unit. The image recorded on the emulsion depends on differences in X-ray absorption by the various constituents in the rock sample. Density variations between quartz and heavy minerals, clays, and other minor impurities are recorded on the radiograph and clearly outline the internal structure of the rock.

The results of this study show that sandstones that seem to be homogeneous, massive, and completely structureless in outcrop and hand specimen actually contain a definite systematic arrangement of grains into small structural units. These units may be horizontal laminae, cross-laminae, micro-cross-laminae, disrupted bedding, or other types of stratification. A massive bed may contain only one structural type or several types in various combinations. The type of structure present seems to be related to grain size. Micro-cross-laminae and disrupted bedding are most common in the fine-grain deposits, whereas large-scale cross-laminae are restricted to coarser sediments.

It is concluded that massive sandstones do not represent special environmental conditions but were formed by the same processes that produce well stratified deposits. On the basis of this study it is doubtful that any sandstones are completely structureless and isotropic throughout.

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Direct Printing of Contour Maps of Facies Data by Computer

A Burroughs 220 computer is being used at Stanford for fitting contour maps to facies data. The computer fits a smoothly curving parabolic surface to the data and then prints a contour map of the surface. Human error in fitting the contours is virtually eliminated. The method is particularly useful where direct contouring of data values is difficult or meaningless because of appreciable random fluctuations and error. The map printed by the computer smooths over the irregularities and shows the general trends. The contoured surface is fitted so that the sum of the squares of the numerical differences of the actual data above and below the surface is the least possible.

This method has been useful in mapping facies variations in a Pennsylvanian limestone bed in New Mexico and variations of modern unconsolidated carbonate sediments in the Gulf of Mexico and adjacent coastal swamps of the Everglades in southern Florida. Ratios, percentages, and average grain diameters mapped in these applications revealed systematic trends that were previously obscure.

Areas mapped by this method must be rectangles, but sampling localities, which may be measured stratigraphic sections, oil wells, or places where sediment samples were obtained, can be arranged irregularly within a rectangle. An arbitrary geographic coordinate system is established so that each locality is described by two coordinate values. The coordinate units may be feet, miles, or, as has been proved convenient, tenths of an inch scaled off the map. The coordinate values and the value to be contoured for each locality form the basic data fed to the computer.

The general instructions for the method are fed from paper tape into the computer's memory before the computation begins. In addition, the computer must be instructed as to the contour interval and the dimensions of the map that it is to print. The contours printed out by the computer consist of individual bands of a letter or symbol, such as A, B, and $. Each band spans one contour interval, and blank bands alternate with printed bands.

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Cross Stratification in Sands of Red River, Louisiana

Sedimentary structures of two modern point bars on a meandering part of the Red River near Shreveport, Louisiana, were investigated by trenching. On one of them, the Beene point bar, 12 sets of trenches, 2–8 feet deep, were dug with a tractor-powered shovel. The trenches ranged from 25 to 250 feet long, and were dug in T-shaped and X-shaped patterns. The point bars consist mainly of fine-grained, well sorted sands, commonly interbedded with and overlain by thin silt layers. Gravelly sands occur in the deeper parts of some of the trenches.

The most abundant type of sedimentary structure is trough (or festoon) cross stratification. Individual trough sets range in size from 1 cm. thick, 5 cm. wide, and 15 cm. long, to at least 1.5 feet thick, 8 feet wide, and 33+ feet long. In any one section, the size of the trough sets tends to decrease upward. The smaller sets are "microtrough" ripple laminae, and occur in the siltier sands and silts. The surface expressions of these ripple laminae appear to be cuspate ripples. The longitudinal axes of trough sets measured at 8 different localities on the Beene point bar have a strong preferred orientation parallel with the local, adjacent, stream flow direction. The resultant vectors obtained by summing observations on individual cross-stratification planes at each locality also point downstream, but have much weaker magnitudes because of the variability associated with the diverse orientations of cross strata within any individual set. In addition to the cross-stratified sands, beds containing parallel, horizontal laminae also occur locally in the siltier sands.

Spoon-shaped depressions on the surfaces of the bars, oriented with the tips of the "spoons" pointing downstream, may represent scours incompletely filled with trough-shaped cross laminae. At the upstream end of one of these scours, cross-laminae in the upper part of the sand which partially fills the scours are overturned downstream. Overturning occurred before deposition of any overlying strata and probably during rapid subsidence of river level.