come a general service field providing new concepts and techniques to industry, but this will require: (1) better utilization of publications and meetings, (2) early declassification of non-critical military information and greater awareness of its availability, and (3) training and utilization of a new class of physical scientist.

As an example, a general investigation into the effects of laser beams on natural targets led to a concept of compositional probing which is specific for one material, ruby. The same principles may have interesting applications in the direct detection of oil and gas at the surface from low-flying aircraft.

In any case, the petroleum geologist needs to be aware that this and other new systems are constantly appearing, and that some of them may aid him in his specialized work.

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MODAL FUNCTIONS OF SEDIMENT SIZE DISTRIBUTION

Variation in sizes of sediment particles deposited together under the same hydraulic regime is related to normal fluctuations in fluid properties and to differences between particle shape and specific gravity. Differences in size-frequency distributions between mineral species can be ascribed to these fluid and sediment properties. A useful way of comparing the differences is by modal sizes.

In heavy-mineral analysis the differences in modal sizes ($\delta\phi$) between each heavy mineral and the light minerals can be used to express the hydraulic equivalence of heavy and light minerals. Modal separation ($\delta\phi$) is a function of shape of the heavy mineral ($Z_H$) and the light mineral ($Z_L$), and of the relative specific gravities of the heavy mineral ($\rho_H'$) and light minerals ($\rho_L'$) in the fluid stream:

$$\delta\phi = \log_2 \left[(Z_L/Z_H)^{0.354}(\rho_H'/\rho_L')^{0.5}\right]$$

A test of this function was made in the heavy minerals in Tertiary sediments of Huerfano Park, Colorado, whose age, mode of deposition, direction of transport, and local source areas had already been established by independent field observations. The mean computed ($\hat{\delta\phi}$) and measured ($\delta\phi m$) modal separations and their statistical deviations are as follows.

| *Mineral* | $\hat{\delta\phi}$ | $\delta\phi m$ | $S$ | $S/\sqrt{n}$ |
|---|---|---|---|---|
| Tourmaline | 0.01 | 1.01 | 0.81 | 0.27 |
| Hornblende | 0.07 | 0.62 | 0.78 | 0.22 |
| Apatite | 0.05 | 0.74 | 0.51 | 0.12 |
| Epidote | 0.36 | 0.14 | 0.50 | 0.14 |
| Sphene | 0.44 | 0.82 | 0.59 | 0.13 |
| Garnet | 0.52 | 0.43 | 0.52 | 0.10 |
| Zircon | 0.61 | 1.10 | 0.69 | 0.16 |
| Ilmenite | 0.62 | 0.40 | 0.47 | 0.09 |
| Magnetite | 0.72 | 0.30 | 0.19 | 0.04 |

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CATIONIC SUBSTITUTIONS IN THE ALUNITE GROUP

Minerals of the Alunite group are designated as $AB_3(SO_4)_2(OH)_6$ with A = Na, K, Pb, $NH_4$, Ag or $H_3O$ and B = Al (alunite) or $Fe^{+++}$ (jarosite). Synthesis studies of Na-K and Al-Fe substitutions produce a series of solid solutions for which natural counterparts have been found. Synthesis has been successful at temperatures ranging from 78°C. to 180°C. with pressures up to 6 atmospheres. At the lower temperatures, analyses show a univalent cation deficiency and an excess of $+H_2O$, indicating the presence of $H_3O^+$. DTA curves of hydronium-bearing jarosites show three endothermic reactions at approximately 350°C., 400°C., and 800°C. The 350°C. reaction is broad and represents a loss of hydronium ion. Similar results have been noted for natural, low-temperature jarosites.

Synthesis of alunites and jarosites with variable K-Na ratios shows a marked preference for $K^+$. The Na-K substitution produces little change on the $a_0$ dimension, but a pronounced effect upon $c_0$ is recorded. The opposite effect obtains upon substitution of $Fe^{+++}$ for Al. The preference for $Fe^{+++}$ in the structure is lowered with increased temperature and reduced acidity.

Currently the parameters controlling the incorporation of Ag and Te in the alunite structure are being investigated.

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SEDIMENT SORTING IN ALLUVIAL CHANNELS

The formation of primary sedimentary structures in and along an alluvial channel occurs as a result of interactions between gravity, the physical characteristics of the sediment and fluid as well as the hydraulic environment. However, the actual process by which recognizable structures develop arises from sorting of the sediment with respect to size, shape, or density, both along the bed and within the stream. The settling rates of the particles, turbulent diffusion, gravitational sliding, and the shear stress in the vicinity of the bed, all contribute to the sorting processes. Certain aspects of the various sorting processes may be predicted by analytical means, whereas others may be determined only by laboratory experiments. Using an alluvial channel together with the normal sequence of bed regimes as a point of departure, a discussion of the underlying principles of the various aspects of sorting in alluvial channels along with some related laboratory experiments is presented in this paper. From the laboratory experiments, quantitative information pertaining to the spectrum of bed forms, including subaqueous dunes and ripples which develop in an alluvial channel, is presented, and the data are compared with existing empirical and analytical relationships. Under favorable conditions of preservation, limited estimates of the hydraulic environment may be made by measuring the physical characteristics of cross-stratified units and related bed forms.

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SHAPE AND STRUCTURE OF SAHARAN CAMBRO-ORDOVICIAN SAND BODIES—PALEOCURRENTS AND DEPOSITIONAL ENVIRONMENT

The older Palaeozoic of the Libyan Sahara consists of the following terms. Above a highly folded Precambrian (Proterozoic) metamorphic series is found a locally restricted intermediate formation called "Infra-Cambrian" as in the eastern Fezzan (Mourizidie formation). The Cambrian consists of a mantle of cross-bedded coarse sandstones of the Hassaouna formation. The absence of feldspars and heavy minerals, except in some areas, and the general orientation of the sedimentary structures lead one to suppose that material was transported some distance from the south (central Africa). What can be the agents of transport and the conditions of deposition—rivers and deltas over a width of several thousand kilometers—or a shallow sea with wave ac-