ISHIWADA, Y., J. SUYAMA

COMPARISON OF TERTIARY BASIN ARCHITECTURE BETWEEN PACIFIC AND JAPAN SEASIDES, NORTHERN HONSHU, JAPAN

No abstract available.

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GLOBAL METALLOGENIC SYSTEMS OF PACIFIC

No abstract available.

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METALLOGENIC PROVINCES OF NORTHEAST PACIFIC

Metal provinces of contrasting sizes and shapes in western North America include deposits of various ages and appear to be largely unrelated to recognized major elements of crustal tectonics, as pointed out by J. A. Noble. When considered in terms of respective structural and petrologic associations, apparent ages, and implied genesis, however, the known deposits can be assigned to metallogenic provinces with a geologically systematic pattern. Five principal kinds of metal concentrations are especially useful in this connection: (1) relatively massive sulfide deposits associated with thick sections of subaqueous volcanic rocks; (2) stratiform deposits in marine sedimentary rocks; (3) stratiform deposits in terrestrial sedimentary rocks; (4) deposits in host rocks of continental orogens; and (5) deposits associated with major volcanic accumulations of continental affinities.

The volcanogenic sulfide concentrations, which provide a long-term clue to crustal concentration processes, include Fe-Cu-Zn-Au-Ag deposits of Precambrian age that may well reflect contributions from a primitive mantle, Fe-Cu-Pb-Zn-Ag deposits of younger Precambrian and Mesozoic ages in less mafic volcanic rocks and associated eugeosynclinal strata, and post-Paleozoic Fe-Cu-Au deposits of the ophiolitic type that evidently represent mantle exhalations along zones of sea-floor spreading. Such exhalations also appear to have been responsible for accumulation of Fe, Cu, Mn, and other metals in pelagic sediments of deep ocean basins during Cenozoic time.

In marked contrast are other deposits that bespeak early separation into the earth's sialic crust of metals such as Mo, W, Sn, U, and V, and continuing differentiation in this direction for Pb, Ag, and Zn. Unlike those of more direct mantle derivation, these deposits evidently have required recycling of metals through various combinations of sedimentation, crustal melting, vapor transport, and new mantle contributions to explain their levels of concentration. Thus current models of metallization along zones of continental rifting, sea-floor spreading, and subduction of oceanic crust can account directly for the development of some important deposits, but they must include at least partly related processes of concentration and reconcentration within the continental crust to explain all of the recognized metallogenic provinces. The copper province of Arizona is perhaps the best example of such complicated interplay over a very long period of geologic time.

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EXPLORATION AND DEVELOPMENT OF NEW HYDROCARBON RESOURCES IN PACIFIC BASINS OF ECUADOR

The Pacific basins of Ecuador have excellent geologic characteristics for the accumulation of hydrocarbons. Geologic, seismic, gravity, and magnetic surveys provided a basis for exploratory drilling in the provinces of Esmeraldas, Manabi, and Guayas. Drilling has produced evidence of petroleum and gas especially in Manabi and Guayas.

Stratigraphically the Pacific basins of Ecuador contain a sedimentary pile which, in the Guayas depression, is up to 30,000 ft thick. Of these sediments approximately 10,000 ft is of Late Cretaceous age, ranging from the Cenomanian to the Maestrichtian. The remaining part of the sequence is Tertiary ranging in age from Paleocene to Pliocene. The lower Tertiary sediments from the Paleocene to middle Eocene offer the greatest interest in the search for hydrocarbons because euxinic facies are present as source rocks and some strata are suitable as reservoirs. Regionally the sedimentary conditions improve toward the south and with them the possibilities of hydrocarbons.

Structurally the area comprises a block-faulted platform which subsided quickly along high-angle normal faults. This permitted the thick column of sediments to accumulate and rapid facies changes are common. Accumulation and entrapment appear to be associated principally with areas affected by faults rather than with true anticlinal folds.

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DEVELOPMENT OF AUSTRALIA'S GROUNDWATER RESOURCES

Most of Australia has no perennial streams hence groundwater has been important in meeting the demand for water. Groundwater was used chiefly for stock and domestic supplies until about 1950 when extraction was greatly increased for irrigation. Groundwater also has been significant in urban water supply in Australia. Usage of groundwater in Australia in 1971 was about 2.5×10^9 cu m and, although some aquifer systems already are fully or overdeveloped, total groundwater resources are well in excess of usage.

Half of the groundwater used in Australia comes from aquifers in the larger sedimentary basins. Most of the remainder is drawn from alluvium and other unconsolidated aquifers. Fractured and weathered zones in hard rocks are important locally.

Groundwater in Australia is used by both the public and private sectors within the overall control, planning, and coordination of the Australian Water Resources Council. Several cases illustrate the interplay of hydrogeologic setting, economics, technologic change, and social attitudes in the pattern of groundwater use.

Few records are available on the use of groundwater prior to the discovery of the Great Artesian basin in 1878. Rapid exploration and development of groundwater with consequent declining yields and inefficient water use resulted in increased investiga-

tions. Groundwater in coastal sands and the alluvium of rivers was used during early settlement but the main growth in usage for irrigation has occurred in the last two decades. The Burdekin delta and the Hunter River Valley are examples. In the Murray-Darling River system interest in groundwater was intensified by waterlogging and soil salinization following intensive irrigation of the riverine plains. Water is supplied from the surface, although recent investigations have shown that many areas contain valuable groundwater resources. In the Perth basin, ground and surface water are being used for expanding urban and industrial developments. Groundwater sources now are incorporated into the existing system. Development of new mineral fields in northwest Australia has depended on availability of large quantities of water. Only groundwater has been able to provide the quantities needed.

To meet the increasing demands for water in Australia from new groundwater sources, the main requirement is for groundwater to be economically, socially, environmentally, and regionally managed.

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ARTIFICIAL RECHARGE OF GROUNDWATER IN BURDEKIN DELTA, AUSTRALIA

Aquifers underlying the 500-sq km onshore part of the Burdekin delta are among the most prolific in Australia. Annual production of groundwater is mainly for irrigation and is in excess of 300 x 10^6cu m. Aquifer thickness ranges from zero, where the river crosses a bedrock bar, to 100 m. Mean annual natural recharge has been estimated at 210 x 10^6 cu m, partly supplied by seasonal rains and partly by the Burdekin River which has a mean annual flow of 10 x 10^9 cu m and yet is ephemeral. The seasonal pattern of recharge and pronounced variations in recharge year by year cause major fluctuations in the water table. Intensive pumping has accentuated water-level fluctuations and in 1971, at the end of a dry period, the water table at one point was 5 m below sea level in an aquifer with a mean transmissivity of the order of 5,000 sq m/d. The short-term problem in the delta is severe fluctuation of groundwater levels and the long-term danger is saline intrusion.

Local water boards have been established to build and operate recharge works—the first such substantive program in Australia. Water is pumped from the river into a system of natural and artificial channels and increasing rates of recharge have been achieved. Pumpage for artificial recharge now is approaching 100 x 10^6 cu m/a. Suspended clay in the recharge water precludes recharge through bores without expensive pretreatment.

Since commencement of artificial recharge the system has had sharply declining recharge rates particularly in the constructed facilities, and in 1971 the Australian Water Resources Council initiated a group of research projects: (1) numerical modelling of the groundwater system, which will provide a basis for design and management of the expanding artificial-recharge program; (2) detailed study of unsaturated flow below the recharge pits, including the effects of low-permeability layers on and below the floor of the pits; (3) the role of the sediment load in the recharge waters in the reduction of recharge rates; and (4) study of the biota of the warm recharge waters and their effect in limiting recharge.

Other studies are in progress on tritium dating of the groundwater to assist in definition of the flow system and on the heterogeneity of the materials around the recharge pits.

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GEOLOGIC ASPECTS OF URANIUM RESOURCES OF JAPAN

Uranium minerals are widespread in Japan and are present in various geologic environments. Significant concentrations of the element, however, are limited to dissemination in Tertiary sedimentary rocks of small basins. These sedimentary rocks unconformably overlie Cretaceous to Paleogene granitic rocks.

The major sources of the uranium of the deposits are believed to be intergranular material and micas of the underlying granitic rocks. The average uranium content of the major granitic bodies in Japan ranges from 1.5 to 5.7 ppm, but in the vicinity of uranium concentration, can be as high as 11 ppm or more.

The uranium in the rocks probably was leached by circulating groundwater containing HCO_3^- ion. Waters within granitic masses contain up to 8.5 ppb uranium whereas the content in average groundwater is less than 0.05 ppb. The element was transported as uranyl bicarbonate complex and deposited under reducing conditions or was adsorbed in clays and other material.

The primary ore minerals of the Tono mine are uraninite and coffinite, but the major form of uranium concentration here seems to be adsorption in montmorillonite and other materials. Recently, interesting and unique deposits of the element, such as a very close association with zeolite and concentration in traps between reverse faults and the basement granite, were found in this mine.

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SUBMARINE PHOSPHORITE DEPOSITS OF CHATHAM RISE NEAR NEW ZEALAND

Phosphorite nodule deposits, with estimated total reserves in excess of 200 x 10^6 tons, are present at an average depth of 350 m on the crest of Chatham Rise. The rise is a broad submarine ridge about 130 km wide and 800 km long extending eastward from Banks Peninsula on the east coast of the South Island, New Zealand, to slightly beyond the Chatham Islands. Preliminary investigations based on exploratory dredging in 1968 by Global Marine Inc. suggest that 65 x 10^6 tons of the phosphorite deposits are concentrated sufficiently to be of economic interest. These more concentrated deposits are mainly in an area of about 4,600 sq km centered 560 km from the South Island.

The phosphate content of nodules ranges from 18.6 to 25.4% P_2O_5, averaging 21.5%. Satisfactory superphosphate can be made from the nodules after they are calcined to reduce their high calcite level. The reactivity of the nodules on the Hoffman and Breen phosphate ore solubility scale is a high 10. Pot trials with rye grass by the New Zealand Fertiliser Manufacturers' Research Assoc. Inc. confirmed the agronomic availability of the phosphate suggesting that finely ground Chatham Rise phosphorite also may have