Tuesday Morning, April 25

JOINT SESSION WITH SEPM

Honors, Awards, Presidential Addresses:
BEN H. PARKER, AAPG
WILLIAM M. FURNISH, JR., SEPM
ORLO E. CHILDS, RMS
Distinguished Guest Speaker: IRA H. CRAM, "Impact of Soviet Oil"

Tuesday Afternoon, April 25

Presiding: W. E. HUMPHREY, CLARK MILLISON

7. Tectonics of Antarctica: WARREN HAMILTON, U. S. Geological Survey, Denver, Colorado

Antarctica has long been considered to consist simply of a large Precambrian shield, flanked on one side by the circum-Pacific belt of Mesozoic and Cenozoic orogeny. The great amount of geologic information obtained during recent years indicates that between shield and circum-Pacific belt are belts of Paleozoic orogeny.

The continent is probably crossed by a late Precambrian and Early Cambrian miogeosyncline whose contents were metamorphosed and intruded by batholiths during the Middle (?) Cambrian. Erratics bearing Lower Cambrian pleosponges, like those characterizing the Adelaide geosyncline of South Australia, have been found in four places; K/Ar dates suggest crystallization about 500 million years ago; and the distinctive granites are remarkably similar to those of Middle Cambrian age in South Australia. This orogen crosses the Antarctic coast between 145° and 160° E., and flanks the Ross Sea and Ross Ice Shelf, and possibly Filchner Shelf and Weddell Sea, as a continuous system of high mountains. These mountains have long been termed the "Great Antarctic horst," thought to be of old Precambrian rocks; the horst concept was based on a misinterpretation of structures near McMurdo Sound, where the broad structure of the present range is anticlinal. At least in the 1,100-mile segment from Terra Nova Bay to the Horlick Mountains, the crystalline rocks are metasedimentary rocks whose structures are subparallel with the mountain system, and distinctive granitic rocks of a composite batholith. Rocks of the orogen are overlain by little-deformed Devonian to Triassic sedimentary strata.

Northeastern Victoria Land, west of the Ross Sea, is composed of metasedimentary rocks, striking generally west-northwestward, whose metamorphism and intrusion by granites occurred about 350–400 million years ago. On strike across the Ross Sea, and trending toward the Weddell Sea at least to the region of 90° W., 82° S., are metasedimentary rocks intruded by distinctive granites which contain relatively large trace amounts of tin. These rocks are undated, but are unlike the Mezozoic crystallines of Palmer Peninsula; a middle Paleozoic age is likely. It may be significant that Devonian granites of eastern Australia are also relatively rich in tin.

The coast between 35° and 165° E. is characterized by charnockites, granulites, and gneisses, in part polymetamorphic, and by varied younger crystalline rocks. The rocks resemble those of the Precambrian K/Ar ages. As has long been recognized, this is part of a Precambrian shield, which may extend farther toward the Weddell Sea, and which presumably extends far toward the South Pole also.

The Palmer Peninsula belongs to the circum-Pacific orogen, as has long been known, and the Thurston Peninsula also may belong to it.

This revised pattern of Antarctic tectonics is essentially that required by Du Toit's reassembly of the southern hemisphere continents before post-Paleozoic continental drift.

8. Andes of West Argentina: ABEL HERRERO-DUCLOUX, DeGolyer and MacNaughton, Inc., Dallas, Texas

The Andes constitute Argentina's western boundary with Chile from Latitude 22°50′ South to Latitude 50°48′ South. The mountain belt of western Argentina consists of a series of sub-parallel meridional chains, which decrease in number, width, and elevation from north to south. Although the Andes may be considered as a single geographic unit, they are formed by several different morpho-structural elements oriented from north-northwest to south-southeast, and therefore oblique to the trend of the continental divide.

The various morpho-structural elements which, from north to south, constitute the Chilean-Argentinian Andes, are as follows: (1) the high plateau of the Puna de Atacama, followed toward the east by the Eastern Cordilleras (Prepuna) and the Subandean ranges, (2) the Pampean ranges, (3) the Precordillera of La Rioja, San Juan, and Mendoza, (4) the Cordillera Frontal, (5) the Cordillera Principal, and (6) the Patagonian Cordillera.

The extension and main stratigraphical and structural features of the different morpho-structural elements, as well as the geologic evolution of western Argentina, are summarily described.

9. Cordillera of Chile, South America: ROBERT N. WILLIAMS, Consultant, Santa Barbara, California

Chile, 2,600 miles long and 100 miles wide, extends from the arid deserts of the North to the cold, windy pampas of the South. It occupies the area from the crest of the Andes to the Pacific Ocean. Geologically, it occupies a long, mobile belt lying west of the stable shield area. Through a series of orogenies it has developed the present Cordilleras. This Andean geosyncline has been a zone of weakness from Precambrian time to the present.

The Andean Cordillera, one of the highest mountain chains in the world, is complicated geologically and tectonically. Two principal provinces can be described, the Eastern and Western, separated by the great central valley of Chile, in which lies the capital, Santiago. The Western Cordillera, the older, represents an extensive batholith of continental character, and is largely granitic in character. Normal block faulting and folding occur. The principal uplift occurred in the Upper Mesozoic. The Eastern Cordillera is composed principally of metamorphic and sedimentary rocks, although evidences of its crystalline core are common. Structurally they show block faulting, with some evidence of thrusting toward the east. Principal uplift occurred during the Tertiary and Quaternary.

Close inshore in the Pacific are troughs 23,000 feet deep. Recent vulcanism is common. At the southern end of Chile the Andes make a strong eastward swing and thence, by an island arc very similar to the Caribbean Island Arc, join the Andes to the mountains of the Palmer Peninsula of the Antarctic, 600 miles south.

10. Bolivia and the Andes—A Geological Sketch: FRANK P. SONNENBERG, Chaco Petroleum, S. A., Cochabamba, Bolivia

Landlocked Bolivia, fourth largest country in South America with an area of 420,000 square miles, extends from approximately 10° to 22° south of the equator and from 58° to 70° west of Greenwich.

Main morpho-structural elements in Bolivia from west to east are the following.

1. The Cordillera Occidental which exposes Tertiary and younger extrusives.
2. The Altiplano depression with thick Tertiary and Quaternary sediments and extrusives in a probable downthrown block.
3. The Cordillera Real, "backbone of the Bolivian Andes," with Tertiary or Mesozoic granitic and quartz monzonite intrusives forming peaks exceeding 21,000 feet and containing the rich tin-mining districts of Bolivia. A southern continuation of this element (without granite) is called the Cordillera Central.
4. The Cordillera Oriental consisting mainly of Ordovician and Devonian sediments. Carboniferous, Cretaceous, and Tertiary sediments are preserved in synclinal cores.
5. The Subandean zone or Andean foothills generally consisting of marine Devonian and continental post-Devonian sediments. The producing oil fields of southern Bolivia are located within this zone.
6. The open country called the Beni plain and Chaco plain in the north and south of Bolivia, respectively, present site of oil exploration activity.
7. The Brazilian shield exposing Precambrian basement.

The Paleozoic section in Bolivia includes rocks from all periods and has a maximum thickness on the order of 40,000 feet. Cambrian, Ordovician, Silurian, and Devonian dominantly shallow marine shales and sands were deposited throughout the Andean and Pampa areas and along the Brazilian shield. At the top of the Ordovician is an unconformity with apparent southward truncation of upper, middle, and lower Ordovician beds. A thin but widespread layer of glacial origin occurs at the base of the Silurian. Sediments of Lower, Middle, and Upper Devonian age conformably overlie the Silurian.

The Permo-Carboniferous sediments consisting of alternating glacial and interglacial deposits of continental origin in southern Bolivia. These become increasingly more marine toward the northwest. Lower Permian limestones known in Peru extend into Bolivia as far as the Subandean zone.

Post-Permian continental type deposition follows; however, age distribution is difficult to establish. A large gap in sedimentation probably exists between Permo-Triassic and Upper Cretaceous. Age of the Vitiacua limestone is questionable.

Thick continental Tertiary deposits fill parts of the Subandean zone and the Chaco and Beni plains, and are known in the synclines in the southern part of the Eastern Cordilleras. A Tertiary sequence of a different type has been found beneath the Quaternary of the Altiplano.

Basalts of Cretaceous, late Tertiary, and Quaternary age are present. Permian basalts found in Peru are rare or absent in Bolivia.

The conspicuous elbow of the Andes in the Arica-Santa Cruz corner possibly had its origin in Precambrian time and has guided the tectonics ever since.

A transcurrent fault zone is believed to have influenced Bolivia tectonics between Corumba-Santa Cruz and probably continuing through the Cochabamba-Oruro areas to the Chilean coast near Arica.

The present Bolivian Andes are the product of a late Tertiary orogeny. By comparison, the earlier orogenies of the Mesozoic and Paleozoic exerted but a mild effect on the structure of Bolivia.

Although lateral compression is generally believed responsible for the folding and faulting of the Andes and of their eastern foothills, some geologists now strongly postulate mostly vertical uplift created the present picture of this impressive mountain system in Bolivia.

11. Role of Sub-Andean Fault System in Tectonics of Eastern Peru and Ecuador: C. K. HAM and L. J. HERRERA, JR., Wm. Ross Cabeen & Associates, Lima, Peru

The Sub-Andean fault system is believed to be the most extensive tectonic feature of the South American Andes. The following discussion is restricted to its role in the tectonics of Peru and Ecudaor. A summary of the regional tectonic features and their histories for Peru and Ecuador is presented in order to orient the reader.

The fault system lies along the eastern front of the Andean ranges demarking the Andean uplift on the west and the potential petroleum province of the Sub-Andean basin on the east. The arcuate trace of this system as well as the trends of the Andean ranges and the Sub-Andean basin parallel the configuration of the western margin of the Brazilian and Guayana Precambrian shields.

The Andean uplift contains Precambrian and Mesozoic plutonic intrusions, Paleozoic metamorphic rocks, Paleozoic, Mesozoic, and Tertiary sedimentary rocks, and Tertiary volcanics. Metamorphic and sedimentary formations are highly deformed by folding and faulting and are commonly mineralized.

The Sub-Andean basin contains a thick sedimentary sequence of Paleozoic, Mesozoic, and Tertiary rocks which overlie a basement of Precambrian igneous and metamorphic rocks similar to that of the shield regions. Foreland folds developed east of the fault system are generally faulted along the eastern flanks and correspond structurally with the compression of deformation characteristic of the Andean uplift. Degree of folding and faulting diminishes eastward toward the shield regions.

The Sub-Andean fault system is an imbricate zone of west-dipping reverse strike faults along which the western blocks are elevated with respect to the eastern blocks. Stratigraphic separations of as much as 15,000 feet have been observed along faults of this system. It is possible that other types of movement, especially lateral movement, have occurred along this system during its history. A set of younger cross faults has subsequently offset the Sub-Andean system.

It is believed that the Sub-Andean fault system has played an important role in the migration of petroleum in the Sub-Andean basin.

12. "Backbone" of Colombia[1]: CYRIL JACOBS, Consulting Geologist, Bogota, Colombia; HANS BURGL, Geology Professor, Universitad Nacional de Colombia; and DANIEL L. CONLEY, International Petroleum (Colombia) Limited

The "backbone" of Colombia is the northern part of the Andes Mountains. The mountain system is here divided into the Eastern, Central, and Western Cordilleras. The Central and Eastern Cordilleras are separated by the down-faulted basin of non-marine Cenozoic deposition through which the Magdalena River flows in its middle and upper reaches. The valleys of the upper Cauca and upper Patía rivers mark the approximate boundary between the Western and Central Cordilleras. The Santa Marta and Perijá Mountains and the Pacific Coast Range are related to the Andean system.

[1] Prepared under auspices of The Colombian Society of Petroleum Geologists and Geophysicists.