

flow, a bright-red welded tuff, and the Rancheria ash-flow rhyolite which forms the prominent cliff on Cerro Rancheria, 50 km north of Chihuahua. In Bellavista Canyon these rocks are overlain by basalt flows, a rhyolite welded tuff (Acantilado tuff) and a peralkaline ash-flow rhyolite (Cryptic tuff). At Punta de Agua, rhyolite tuffs, breccias, and flows overlie these rocks on an erosion surface of considerable relief, like that of today. West of Cumbres de Majalca, flat-lying Acantilado-type (30 m.y.) ash-flow rhyolites form a dissected, westward-sloping plateau. West of Bellavista, basalt flows are overlain by the Acantilado which has a major vent in Sierra Rusia. The Sierra Campana (80 km north of Chihuahua City) is composed of Cryptic-like ash-flow rhyolites with the peralkaline Campana tuff on top. Thick ash-flow and vertically foliated rhyolites mark a vent for the Cryptic in lower Santa Clara Canyon. Flat-lying basalt and basaltic andesite, Acantilado tuff, and Cryptic tuff extend westward to Ojos Azules. Below the Acantilado, basalts are dominant in lower Santa Clara Canyon, but rhyolite tuffs and breccias become prominent westward. Small rhyolite vent complexes are exposed near Rancho Manta Negra and Las Varas. The large volumes of Tertiary rhyolites (including peralkaline types) indicate that this region has potential for those types of uranium deposits that are closely related to felsic volcanic environments.

MEGAW, PETER K., Sage Associates, Tucson, AZ

Volcanic Rocks of Sierra Pastorias Caldera Area, Chihuahua, Mexico

The Sierra Pastorias lie just south of Chihuahua City, Mexico. The area contains two resurgent caldera systems and one nonresurgent caldera. With minor variations, both resurgent calderas follow Smith and Bailey's model closely. The major caldera is 22 km in diameter and is characterized by a 600-m thick, densely welded, lithic-rich, two-feldspar, intracaldera facies ash-flow tuff core, surrounded by moat-zone sediments and voluminous porphyritic rhyolite flows. A minimum of 200 cu km of tuff was erupted. The smaller resurgent caldera is 10 km in diameter and it ejected at least 60 cu km of ash-flow tuffs similar to those of the major caldera. Both resurgent calderas are domal structures with apical grabens. Each dome is ringed by vertically foliated rhyolite necks which intruded along the ring-fracture zones. Nested within the major caldera is a nonresurgent caldera which erupted poorly welded, sanidine "moonstone" bearing tuffs.

The composite section has a total thickness of nearly 3,000 m. Rhyolite ash-flow tuff accounts for 80% of this, with fluvial rhyolite, volcanoclastic sediments, and olivine-augite-bearing basalt comprising the remainder. A small volume of rhyolite intrusion is also present.

Chemically, the rocks define a quartz-normative, bimodal suite composed of calc-alkaline rhyolite and basalt. The alkalinity and other chemical characteristics of these rocks fall between those typical of the Sierra Madre Occidental and eastern Chihuahua; the parental magmas were probably generated by subduction-related processes. No ages have been determined.

MILLER, FORREST, Forrest Miller Exploration, Carlsbad, NM

Washington Ranch Morrow Field: Case History in Frontier Exploration

The Washington Ranch Morrow gas field is located 35 mi (56 km) southwest of Carlsbad, New Mexico, on the western

rim of the Delaware basin 6 mi (10 km) basin-ward from the Capitan reef front.

Late Pennsylvanian orogenic forces created a structural development of such sharp magnitude that most exploration outlook condemned the area as too disturbed for commercial hydrocarbon entrapment. The northwest-southeast-trending fault on the northeast side of the field has a displacement of more than 2,000 ft (610 m), structural contours on the basal Morrow sandstone unit define 600 ft (183 m) of closure against the fault. The crest of the structure has lost 1,700 ft (518 m) of Wolfcampian and Upper Pennsylvanian section through erosion and nondeposition.

Eight deep dry holes had been drilled within an 8 mi (13 km) radius of the drill site for the discovery well. Several of these wells had encountered a significant igneous sill only 400 ft (122 m) below the basal Morrow sandstone. The presence of this sill so close to the main potential reservoir rock further detracted from the prospect. Reefing development of two separate ages in Pennsylvanian sediments caused very rapid lateral facies changes which made well log correlations difficult.

Frontier exploration philosophy and technique were employed to overcome the many negative considerations of the prospect. The discovery well was completed in June 1971 for a calculated absolute open flow potential of 54 MMCFGD natural, through Morrow perforations at 6,795 to 6,806 ft (2,071 to 2,074 m). While drilling was in progress gas flowed at the rate of 22 MMCFGD on a 2-hour and 10-minute drill-stem test from 6,791 to 6,860 ft (2,070 to 2,091 m). Major gas reserves were made available to the pipeline with the drilling of nine development wells.

MITCHELL, STEPHEN, D. V. LEMONE, and N. E. PINGITORE, Univ. Texas, El Paso, TX

Carbonate Facies of Sierra Gomez, Chihuahua, Mexico

Sierra Gomez, approximately 20 km east of Aldama, Mexico, consists of approximately 500 m of folded and thrust middle Cretaceous massive to thin-bedded mudstones and wackestones. Thin-bedded units are generally laminated and show local soft-sediment deformation. The laminated carbonates are dark-gray, with some bedded, black chert and contain gastropods, oysters, and the bivalve *Corbula*. Massive units are generally dark-gray to tan, with chert nodules and stylolites, and contain rudists, oysters, corals, and gastropods.

The silicified megafauna includes abundant bivalves such as radiolitid and toucasid rudists, *Ostrea* sp., *Corbula* sp., *Granocardium* sp., and several other genera. At least five species of gastropods have been found that include at least two species of *Turritella* and *Heliocryptus planorbis*. Abundant corals as well as worm encrustations and sponge borings (*Clinos*) are also recorded.

These limestones have been described as basinal facies of the Aurora Limestone. A significant portion of the megafauna has apparently not been transported. Shallow-water deposition is also indicated by the presence of rudists in apparent growth position. Normal marine conditions are established by the presence of the stenohaline coelenterates.

MITCHELL, STEPHEN, and PHILIP C. GOODELL, Univ. Texas, El Paso, TX

Geology of Sierra Gomez, Chihuahua, Mexico

The uranium deposits of Sierra Gomez, Chihuahua, consist of hexavalent uranium mineralization in middle Cretaceous