Facies of the Waltman depositional system, in basinward progression, include distal alluvial-fan, proximal fan-delta, delta-front, and prodelta. This sequence of facies exhibits an increasing influence of lacustrine over fluvial processes. Depositional environment of each facies is interpreted through examination of outcrop and subsurface characteristics, and supported by analogy with other ancient and modern depositional systems.

Sedimentation was largely controlled by the tectonic behavior of the source area and receiving basin. Rapid subsidence of the basin relative to the source area resulted in three vertically stacked fan-delta lobes in the study area. Uplift of the source area relative to the basin subjected preexisting formations and facies to erosion and redeposition. Climate and basin morphology (which controlled storm activity), stream runoff, waves, currents, basin slope, water depth, and water salinity were also factors which influenced sedimentation within this depositional system.

PICKETT, GEORGE R., Colorado School Mines, Golden, CO

Integrated Exploration: Frustration, Fulfillment, or Fun?

The development of optimum integrated exploration has both technical and humanistic aspects. Experience in the borehole-geophysics field with integration of measurements shows the connotations for integration of measurement systems (e.g., seismic and borehole) on more ambitious scales. It is concluded that many of the technical tools needed for effective integration are already available. The challenges and opportunities posed by the humanistic aspects are considered. Modes of integrated exploration suggested by experiences of organizations and conclusions to be drawn from these experiences are reviewed.

PIGOTT, JOHN D., Univ. Oklahoma, Norman, OK

Carbonates, Evaporites, Red Beds, and Organic Shales—Global Tectonic Model for Their Chemical Cycling and Hydrocarbon Potential

The partitioning of oxidized and reduced species of exogenic carbon and sulfur, as calculated from secular Phanerozoic trends in $\delta^{34}S$ and $\delta^{13}C$, suggests a strong coupling between major reservoir transfers and global changes in sea level due to geotectonic mechanisms. The stoichiometry of the major reservoir transfers can be approximated by two tectonic-geochemical end-member scenarios.

*Scenario I*—high ridge volume, high spreading rates, high global sea level:

$$Me^{2+}CO_3 + SiO_2 + 8CaSO_4 + 2Fe_2O_3 + 15CH_2O \rightarrow Me^{2+}SiO_3 + 4FeS_2 + 8CaCO_3 + 15H_2O + 8CO_2.$$

*Scenario II*—low ridge volume, low spreading rates, low global sea level:

$$Me^{2+}SiO_3 + 4FeS_2 + 8CaCO_3 + 15H_2O + 8CO_2 \rightarrow Me^{2+}CO_3 + SiO_2 + 8CaSO_4 + 2Fe_2O_3 + 15CH_2O.$$

Scenario I tends to be a time of globally widespread carbonates, elevated carbon dioxide, warmer temperatures (greenhouse effect), extensive iron sulfides, light $\delta^{13}C$ and heavy $\delta^{34}S$. Conversely, scenario II represents a time of globally widespread evaporites, red beds, reduced carbon, carbon dioxide consumption, more frequent glaciation, heavy $\delta^{13}C$ and light $\delta^{34}S$.

These secular trends which track the first-order sea-level curve have important bearing on global hydrocarbon-reservoir and source-rock strategies. Owing to elevated carbon dioxide in scenario I, the widespread carbonates on the flooded shelves would tend to be composed of allochems and marine cements of metastable aragonite and/or Mg calcites greater than 8 mole % Mg. Such compositions are vulnerable to becoming excellent secondary porosity reservoirs. The carbon dioxide concentrations might also enhance the "anoxic" preservation of source-rock organic matter in areas where slow depositional rates would normally lead to oxidation of reduced carbon before burial. Scenario II, on the other hand, would yield less favorable conditions for carbonate reservoir development. This would be a result of both a decrease in areal extent (lower sea level, increased clastic input) and a general decrease in potential secondary porosity development owing to the lower carbon dioxide levels which lead to a dominance of more stable non-aragonite Mg calcitic (less than 8 mole % Mg) allochems and marine cements. However, the source-rock potential at this time would tend to be generally favorable owing to the greater global storage of reduced carbon. Furthermore, scenario II would also represent a time of widespread areas for the potential application of a variety of evaporite and red-bed play concepts.

PILGER, R. H., JR., and JEFFREY A. NUNN, Louisiana State Univ., Baton Rouge, LA

Residual Temperature Analysis—Tracking Subsurface Fluid Migration

Positive temperature anomalies associated with fluid-migration paths are expected effects within a compacting and dewatering sediment pile. However, temperature anomalies are also produced by lateral variations in thermal conductivity of the sediments. Using established relations between thermal conductivity and seismic velocity, an estimate of regional heat flow, and average surface temperature, it is possible to estimate the local geothermal gradient (due to solid state, one-dimensional conduction) from sonic logs or downhole velocity surveys. Subtraction of such calculated temperatures from corrected bottom-hole or log temperatures produces mappable residual temperature anomalies which can be interpreted as effects of active upward fluid migration. Mapping of such residual temperature anomalies and comparison with structural setting provide a stronger tool for interpreting routes of water (and perhaps hydrocarbon) migration, than using temperature values without removal of conductive effects. The procedure is analogous to removing a predicted regional gravity field to produce residual gravity anomaly. Interpretations are strengthened by mapping calculated fluid pressure and salinity anomalies which might also be attributable to fluid movement.

Examples from the Louisiana Gulf Coast Miocene illustrate the application and promise of the technique. Residual temperature anomalies occur close to faults, suggesting the potential importance of such structures as routes for fluid escape. The method also provides a means of interpreting correspondence of thermal highs with structural highs as products of either conductive focusing or fluid movement up structure, though two- or three-dimensional modeling is required.

PORTO, ROBERTO, and PETER SZATMARI,* PETROBRAS, Rio de Janeiro, Brazil

Classification of Onshore Sedimentary Basins in Brazil

The major sedimentary basins of Brazil range in age from late Proterozoic to Cenozoic. They overlie a stable Precambrian craton consolidated by several orogenic events. Two major regions can be distinguished in this basement: the relatively calm Amazonic Province and the strongly tectonized Atlantic Province, welded together 900 to 1,200 m.y. ago.

The oldest of the major superimposed basins is the Bambui (Sao Francisco) basin, whose sedimentary sequence was, especially along the margins, slightly folded and metamorphosed during