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How to Correct Seismic Data to Improve Seismic Impedance Logs

Besides geometrical and velocity effects, two global parameters may disturb the comparison between acoustic logs recorded in a borehole and those derived from seismic data: (a) the amplitude spectrum of the basic seismic wavelet, which controls the power of resolution; and (b) its phase characteristics that monitor the resemblance. The latter is of major importance in stratigraphic interpretation of seismic impedance logs (recognition of geologic transitions). The most important causes of distortions can sometimes be determined and compensated. The seismic source signature needs to be recorded, analyzed, and processed to determine the seismic wavelet. Phase distortions due to recording equipment (geophones and laboratory) are very important, and need to be corrected. Travel into the earth introduces multiples and absorption. Multiples can be dealt with in the classic way with a few precautions. Then an estimation of the amplitude spectrum of signal and noise at a given time-depth provides one with a quantitative estimate of the best achievable resolution of the actual data, and the absorption curve in amplitude spectrum using the recorded source spectrum. A good match between experiments and theory leads to the estimated impulse response of absorption at a given time, and reversely, to an optimized (eventually time-varying) correction operator.

Further conventional deconvolution processes should not be used. Nevertheless, when distortions cannot be corrected, and if well data are available, a deconvolution program controlling both amplitude and phase can be used interactively to achieve an equivalent result.

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Paleobotany, Paleoenvironments, and Stratigraphy of Lower Kirtland Leaf Locality near Bisti, San Juan Basin, New Mexico

A new leaf locality has been discovered in Hunter Wash, near Bisti, in a sequence of mudstones, carbonaceous shales, siltstones, sandstones, and coal. The boundary between the Fruitland and Kirtland Formations is taken at the top of the highest carbonaceous shale above the highest Fruitland coal and below a prominent brown sandstone. The leaf locality lies within a 19-m measured section, about 4.3 m above the highest carbonaceous shale, within a gray-green shaly siltstone overlain by a sideritic concretionary lens. Poorly preserved bivalves and gastropods occur in the deposit, but leaves predominate.

Leaf collections contain the remains of ferns, conifers, and angiosperms; angiosperms dominate the assemblage. The most commonly found angiosperm genera found include *Cercidiphyllum, Cissus, Ficus, Laurophyllum, Myrtophyllum, Lantanus, Salix,* and *Rhamnus*. Study of the collection to date shows that most of the angiosperous leaves are of medium size with entire, or nearly entire margins and drip points. These features indicate a warm temperature to subtropical climate in the region during early Kirtland time.

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Seismic Amplitude Variations and Detection of Sand Bodies

An area offshore Louisiana with an abundance of well control and seismic data provides an opportunity to verify the presence of interpreted sand bodies. In gross aspect the seismic sections show two major zones: one with highly discontinuous reflections of modest amplitude and a deeper zone with continuous parallel reflectors of low amplitude. The latter is due to an overpressured shale section interrupted by poorly developed sands and hard streaks, while the former is dominated by laterally discontinuous blocky sands which can be readily mapped from seismic events. Looking at the sands in more detail, the reflectors are actually continuous, following time-lines, but the amplitudes diminish where the sands terminate. Thus, reflector amplitudes can be used to determine the distribution of sand bodies of the order of 70 to 100 ft thick. In one area a sand body can be mapped across a structural nose, delineating a structural/stratigraphic trap, and elsewhere the presence of gas is distinguishable from lithologic changes by the intensity and character of the associated seismic signature.

One-dimensional modeling indicates that seismic response to the sand depends principally on density contrast with the shales. Two-dimensional modeling based on well log parameters and seismically derived geometries suggests that the sand bodies may be due to localized deposition and have been enhanced by differential compaction.

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Dilation Brecciation—Proposed Mechanism of Fracturing, Petroleum Expulsion, and Dolomitization in Monterey Formation, California

The Monterey Formation has been selectively replaced by dolomite and subsequently fractured, brecciated, and relithified with several generations of dolomite cement. The two dolomite types are distinctive in morphology, color, stoichiometry, δC^{13}, δO^{18}, as well as insoluble and trace element content.

Dilation breccias evidently originate in embrittled rocks through a distinctive sequence of steps induced by tectonism: dilatancy, fluid expulsion, natural hydraulic fracturing, brecciation, hydroplastic flow, injection, and dolomite precipitation. Development is most abundant in, but not restricted to, areas of strike-slip faulting.

Initially, breccia clasts are angular, large, and closely fitted. In advanced development, smaller clasts appear unsupported and volumetrically subordinate to fracture-filling dolomites. Complex examples contain a very wide range of unsorted clasts and cement, similar to a slurry. They appear to be injected under pressure into swollen bedding planes and terminal fractures.

Tectonic stresses cause an initial compression and subsequent dilation (elastic) of rock microcracks and imperfections. With continued stress, the cracks are propagated inelastically and develop into major fracture networks. Fracturing associated with excess pore fluid pressures triggers an instantaneous flow of connate fluids across several hundred feet of newly fractured strata. The resulting sharp drop in fluid pressure and temperature causes rapid precipitation of fracture-healing dolomite. The relithified rock is then subject to renewed dilatancy and rupture.

The dilatancy is pervasive and sufficient in magnitude to cause the expulsion of indigenous petroleum held initially in the organic matrices of the relatively impervious Monterey Formation. Several periods of petroleum migration are recorded in breccia paragenesis.

Dilation breccia is a distinct form of nondepositional breccia. It probably occurs in many tectonic provinces.

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Laboratory Simulation of Organic Diagenesis Leading to Oil and Gas Formation

Simulated maturation experiments involving sediments of different source environments give quantitative and kinetic information about generation of petroleum and natural gas. Starting material, temperature, and heating time all play critical roles in determining quantity and type of reaction products. Samples from recent peaty lacustrine and algal mat lagoonal deposits were heated separately in closed systems for 1 to 15,000 hours at temperatures ranging from 35 to 550°C. Reaction products were monitored for both quantity and isotope data. Low molecular weight volatile compounds (C_1-C_5+, H_2, CO_2) and petroleum-range (C_{15}+) hydrocarbons were products.

Petroleum product formation occurs in three stages. A premature stage is characterized by production of volatile hydrocarbons and carbon dioxide but little change in C_{15}+ components. The volatile products are a result of kerogen and humic rearrangements and display marked kinetic isotope effects. In the mature stage, the original biologically related C_{15}+ hydrocarbon fraction is diluted by catagenetically derived products. Methane formed in this stage is derived from C_{15}+ components and is characterized by stable carbon isotopes 15 ppt lighter than the starting material. A postmature stage displays C_2-C_5+ and CO_2 reduction, forming isotopically heavy methane.

Temperature affected the rate of product formation but not the kinetic order governing the reaction or the ultimate production potential for petroleum-like hydrocarbons. Organic source affected both rate of hydrocarbon formation and specific intermediary products of thermal alteration. Peaty organic matter matures more quickly than algal material given the same thermal stress.

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Future Success Factors for Petroleum Geologists or What They Don't Teach in Departments

Educationally, today's graduates in geology are relatively well equipped. Yet, the post-academic success of these geologists relates to factors not in geology curricula or stressed by advisors. Although most supervisors consider technical competence, they base promotions and raises more on qualities of writing, oral presentation, work habits, creativity, initiative, logic, problem analysis, personality, and even appearance, rather than on geologic skills. Management selection often depends on impressions at conferences and brief contacts rather than on geologic aptitude. The formal evaluation system of companies often stresses non-geologic skills. Typical appraisal forms rate quality and quantity of work, initiative, creativity, judgment, relations with people, work habits, effectiveness of supervision, and other performance factors. Frustrations with paperwork and organizational procedures, and the resulting dislike for administrative activities, result from poor non-geologic management skills as much as the problems themselves. Success in pure staff geologic jobs depends on logic, creativity, writing, and speaking ability. In addition to teaching geologic skills, a professor's success depends on his ability to relate to, communicate with, and inspire students.

Solutions to these problems are difficult. Students and young geologists must become aware of these important factors. Curricula should be broadened and strengthened in these areas. Report writing and presentation should be emphasized in geologic course work. Course success should depend more on aptitudes in grammar, organization, logic, and spelling. Companies should include non-geologic factors in their training programs. Societies should include these critical factors, governing future success of members, in their short courses.

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Boundary Problems Between Carboniferous and Permian Systems

Defining the perplexing systemic boundary between the Carboniferous and Permian Systems may be an unresolvable problem. In northwestern Europe, the type Upper Carboniferous rocks are represented by a nonmarine facies, the Permian rocks are represented incompletely by shallow-water, evaporitic, and dolomitic beds. The type Permian sections along the western flank of the Ural Mountains also have shallow-water, evaporitic, and dolomitic beds and red beds. There, Permian beds overlie a series of marine limestone facies comprising abundant and diverse marine faunas, but whose age relations to the nonmarine Upper Carboniferous beds of northwestern Europe are equivocal. During the last 100 years, Soviet geologists have proposed lowering the base of the Permian to various positions in these marine limestones and have tried to locate a natural boundary, as defined by faunal changes. However, any boundary established within this succession will be arbitrary because major evolutionary changes in the different marine fossil groups are not synchronous.

In other parts of the world, Upper Carboniferous and Lower Permian rocks and faunas reflect strong influences of depositional conditions and faunal provinciality. The faunal provinces comprise cold water faunas for much of Gondwanan continents, warm water to tropical water faunas for the Tethys and western Panthalassa, and tropical water faunas for eastern Panthalassa.

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Bed Forms, Facies Association, and Tectono-Stratigraphic Setting of Proterozoic Eolianites, Hornby Bay Group, Northwest Territories, Canada

The Hornby Bay Group is a middle Proterozoic (1.8 to 1.2 b.y. ago), 2.5 km thick succession of terrestrial siliciclastics overlain by marine siliciclastics and carbonates. Deposition initially occurred in isolated intracratonic depocenters. Infilling of rugged basement topography by alluvial fans and braided rivers was followed by deposition of more than 500 m of mature quartzarenite on a low-energy braidplain. Three facies assemblages within this sequence are interpreted as eolian.

Facies A (80 to 200 m thick) interfingers with alluvial fan deposits. It displays low-angle tabular-planar cross-bed sets with wedge-shaped intrasets, ripple cross-lamination perpendicular to foreset dips, and climbing ripples proximal to the fan deposits and large trough cross-beds with wedge intrasets in distal parts of the basin. This facies records deposition in complex transverse bed forms. Facies B consists of lenses up to 40 m thick interlayered with low-energy fluvial deposits. Composed of 3 to 4 single low-angle trough cross-beds with numerous smaller intrasets, it is inferred to represent bar-