

foam was tagged with fluorescing, ultraviolet paint pigment to enable its pathway to be mapped with a short wave ultraviolet light.

As mining advanced toward the holes, the lithologic characteristics of the coal seam, roof, and floor were mapped, along with the location of roof falls and deformational features. The roof strata consisted of thin, irregular pods of gray shale and siltstone and of an overlying sandstone, which had an erosional contact with the seam in many areas. Roof falls and "slips" occur where the roof's lithologic character is transitional from shale to sandstone. The falls occur with time as the roof weakens along slip planes and bedding planes where individual lithologic characteristics are not thick enough to support themselves.

Paint pigment from the treatment fluid was distributed in horizontal planes at the coal-roof interface and along the top of an in-seam rock binder up to 225 ft (70 m) from an individual borehole. Propping sand was found only on the top of the rock binder and in vertical fractures in the lower bench of the seam, near the boreholes. Fluorescing vertical fractures occurred predominantly in the friable lower bench and extended outward for a distance of up to 160 ft (50 m) from the boreholes. No fractures penetrated the roof or floor strata. No roof falls occurred near the well bores.

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New Madrid Seismic Zone: A Test Case for Naturally Induced Seismicity

Induced seismicity caused by man-made events, such as the filling of reservoirs has been well documented. In contrast, naturally induced seismicity has received little attention. It has been shown that a fluctuation of as little as several bars can trigger reservoir induced earthquakes. Naturally occurring phenomena generate similar fluctuations and could trigger earthquakes where the faults in ambient stress field are suitably oriented and close to failure.

The New Madrid Seismic Zone (NMSZ) presents an ideal test case for the study of naturally induced seismicity. The ideal data set for a study of triggering effects must contain a statistically significant number of events, a constant accumulated strain, and a limited focal region. New Madrid earthquakes are well documented from 1974 to the present, down to a magnitude ~ 1.8 . They lie in a distinct fault pattern and occur as a reaction to the regional stress regime.

A statistical correlation was made between the earthquakes and a variety of different types of loads, to see if New Madrid seismicity could be triggered by natural fluctuations. The types of "triggers" investigated ranged from solid earth tides to variations in barometric pressure, rainfall, and stages of the Mississippi River. This analysis becomes complex because each factor investigated creates individual stresses, as well as having imbedded in it a reaction to other factors. For example, changes in barometric pressure influence the observed solid earth tides, as well as leading to rainfall, which in turn cause changes in the river stages. Most likely it is a combination of effects, reinforcing each other, that act as possible trigger sources.

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Tectonic History of Southeastern Illinois

Recurrent movements on the northeast-trending Reelfoot rift and west-trending Rough Creek fault zone dominated southeastern Illinois tectonic history. Early Cambrian rifting along both zones created deep trenches that began to fill with sediments. Intermittent movements continued, but faults were quiescent by the Mississippian. Then renewed extension on the Reelfoot rift in the Early Permian produced high-angle normal faults in the Wabash Valley fault system and Fluorspar area fault complex, and the right-lateral Cottage Grove fault system. Igneous intrusions accompanied this action: upwelling magma formed Omaha dome; Hicks dome and associated concentric and radial faults appear to have been formed by explosive igneous activity.

After the Early Permian, recurrent up-and-down movements of several thousand feet reactivated the fluorspar area fault complex and created the present day Rough Creek and Shawneetown fault zones. Blocks bordering faults returned roughly to their original positions by the Late Cretaceous, leaving narrow slices of rock upthrown and downthrown along faults.

Faults in Illinois probably have been inactive since the Cretaceous Period, although the Reelfoot rift south of Cairo has been reactivated. Earthquakes in Illinois today apparently are caused by local east-west horizontal compressional stresses not related to known bedrock faults.

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Coal Mine Ground Control—The Effect of Geology

The stability of an underground coal mine is highly influenced by the regional and local geologic conditions. Certain geologic features have an effect on roof and floor stability. A method of engineering geological data collection involves engineering geological mapping, diamond-core drilling, geotechnical logging, borescope observations, integral sampling of floor strata, and in-situ stress measurements. Individual aspects of the method were developed and tested during the course of field investigations at three Pennsylvania and West Virginia coal mines. The field investigations were supplemented with laboratory testing of rock and coal specimens and regional geologic studies involving lineament and hazard analyses. The method of engineering geological data collection was found to be effective for quantifying geologic conditions in parameters directly applicable to engineering design.

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Biofacies and Habitats of Brereton Limestone Member (Carbondale Formation, Middle Pennsylvanian), Southwestern Illinois

The Brereton Limestone is a shallow-water, open-marine carbonate deposited over peat or delta-plain muds after delta abandonment and a marine transgression. Six distinct biofacies are recognized, utilizing quantitative analysis of abundance data on 32 fossil types obtained from detailed petrographic examination of 141 samples. The biofacies partly overlap and probably represent coexisting paleocommunities. Data on autecology, lithology, insoluble residue content, and thickness were used to interpret the habitats of each biofacies.

Biofacies V, a low-diversity biofacies dominated by brachiopods and ostracods, occupied turbid-water, mud- or shelly mud-bottom areas during influxes of detrital clays late in the abandonment of the Herrin delta and, also, early in the construction of the Jamestown delta.

Low-relief carbonate mud mounds accumulated within and around baffles provided by thickets of phylloid algae, crinoids, fenestrate bryozoans, or productid brachiopods, and are separated by narrow to broad intermound areas. Shallow-water mud mounds, containing Biofacies I, which is dominated by calcareous phylloid algae and foraminifers, are capped locally by Biofacies VI, a low-diversity biofacies dominated by ostracods. Biofacies VI, occupied the high subtidal to supratidal crests of algal mud mounds which had a stressed (possibly hypersaline) environment. Deeper water mud mounds were occupied by either Biofacies III, a crinoid-mixed fossil biofacies, or by Biofacies IV, which is dominated by fusulinids, strophomenids, and trilobites.

Biofacies II, dominated by sponges, mollusks, and impunctate brachiopods, generally occurred on the flanks of the shallow-water mounds. Biofacies I, III, and IV also occurred in broad, muddy intermound areas and Biofacies III in narrow, winnowed intermound areas.

Spatial distribution of biofacies and inferred habitats is characterized by irregular and local changes, and does not conform to regular, predictable changes perpendicular to a paleoshoreline.

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Morphotectonic Features Interpreted from Remote Sensing, Erie County, Northwest Pennsylvania

Linear features (lineaments) have been discerned in Erie County from multi-temporal Landsat MSS images and return-beam videcon scenes. This 2,107 km² (814 mi²) portion of the Appalachian Plateau is crisscrossed by at least 24 Landsat linear features, some of which may be of