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The Decaturville, Missouri, impact structure: A geologic summary with map

By

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The Decaturville structure of central Missouri is ascribed to meteorite or comet impact, on the basis of structural style and the presence of diagnostic shock features. The intense deformation in a circular area 3.5 mi (5.5 km) across is in marked contrast to the surrounding flat-lying strata of the Ozark Plateau. A circumferential normal fault bounds the structure which consists of a central uplift and surrounding structural depression. In the central uplift, Cambrian sandstone, dolomite, and shale normally 1000 ft (300 m) or more deep are exposed, and isolated blocks of Precambrian basement pegmatite and schist occur 1800 ft (540 m) above their normal position. Convoluted strata in the uplift have strike lengths 25-30% longer than the perimeters on which they lie, indicating that inward movement and crowding of beds accompanied the upward movement. The inward movement involved folding and thrusting and was succeeded by adjustments on steep faults with both upward and downward displacements of as much as 500 ft (150 m). The structure of the depressed zone around the uplift is characterized by generally concentric inward and outward thrusts, and by steep faults which formed both before and after thrusting took place.

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Shock features include monolithologic and mixed breccias, shatter cones, planar features in quartz, and intense intragranular deformation. Monolithologic breccias, formed by successive dilation and crushing of individual beds without mixing of adjacent beds, are common throughout the structure. Shatter cones occur at the center of the structure in a circular area about 1500 ft (450 m) across. The shatterconed rocks form a capping layer over a megabreccia column containing blocks up to a few hundred feet (several tens of metres) in size. These blocks are from formations which make up the bottom 800 ft (240 m) of the 1800-ft (540 m) disturbed sequence, and are jumbled without regard for original stratigraphic order. The blocks are in a matrix of fine-grained mixed breccia which contains quartz grains with close-spaced planar features, including some parallel to $10\bar{1}3$, probably indicating shock pressures as great as 60-100 kilobars. Shock effects decrease in intensity downward; the basement rocks do not certainly contain shock features. The deepest point of shock-energy release is not well defined, but was not deeper than about 1200 ft (360 m) in the disturbed section.

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Because the Decaturville structure is one of several features (volcanic, or of uncertain explosive origin) which lie in general alinement across southern Illinois, Missouri, and Kansas, it commonly has been ascribed to origin by endogenetic explosion. A subterranean explosion, however, would result in dilation and outward dislocation rather than centripetal movement of beds in the central uplift, and it cannot explain shock deformation at pressures far too great to be sustained beneath a few hundred feet of strata. Decrease of shock deformation downward also implies energy applied from above rather than below. In addition, the structure has many similarities to known impact structures and is unlike any proven endogenetic structure.

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The structure is of considerable paleogeographic interest because it contains the only known occurrences of the Silurian Edgewood and Bainbridge formations and Noix oolite (or possible Thebes equivalent) in that part of Missouri. Exposures of Cambrian formations in the uplift are also unique in central Missouri. Blocks of units normally 600-1800 ft (188-564 m) deep lie on the youngest formations in the ring depression; these are interpreted as crater ejecta or fallback, which suggests that original ground surface is present in parts of the depression. On this basis, depth of post-structure erosion in the area is estimated to be no more than 150 ft (47 m). This amount of erosion probably obliterated the post-impact apparent crater, which must have been relatively shallow, but it could not have destroyed the initial transient cavity estimated to be 11,000 ft (3,300 m) in diameter and 1800 ft (564 m) deep. We believe the crater was destroyed by the immediate inward movement of beds to form the central uplift. This movement was a response following passage of the shock wave, and produced the ring fault and structural depression (to form the apparent crater) as necessary concomitants to the development of the central uplift (volumes of the uplift and drpression are virtually equal). As the transient cavity closed, material spalling from the walls was trapped to form the megabreccia mass at the center of the structure. This explanation may apply to other astroblemes where erosion is not thought to be great but where a central peak is present without a topographic crater.

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The age of the Decaturville impact structure is not definitely known, but is almost certainly post-Pennsylvanian, and may be younger than Cretaceous.

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GENERALIZED GEOLOGIC MAP OF THE DECATURVILLE, MISSOURI IMPACT STRUCTURE

EXPLANATION

Generalized geologic map of the Decaturville, Missouri impact structure

	x	Kimmswick limestone (includes 2 localities of Silurian limestones on west side of structure)
Ordovician	j	Jefferson City formation
	r	Roubidoux formation
		Gasconade formation (Gunter member at base)
		Eminence formation
Cambrian		Potosi formation
		Derby-Doerun formation
		Davis formation
Precambrian	•	Pegmatite and schist
	———	Fault
	- - -	Geologic contact

Missouri Route 5 and Decaturville village (approximately 37°54' N: 92°42'W) shown for location.

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