The Geology of the Kansas Basement: Part II

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Abstract

The identification of deficiencies and errors in the presuppositions and methods of uniformitarian natural history should be accompanied by an empirical reinterpretation of geological data within the Biblical worldview. The wealth of geological and geophysical data demands a systematic replacement of the ruling paradigm by creationist explanations of the rock record. Such a reinterpretation is underway for the geology of Kansas, and the first step in that project addresses the basement. The erosional contact between the crystalline basement and overlying sediments can be interpreted as the erosional basal Flood boundary. The exception to this interpretation is found at the Midcontinent Rift System, a complex of basalt flows and adjoining sedimentary basins. This feature is interpreted as the tectonic basal Flood boundary, marking tectonic disruption associated with the Flood onset, with both basalt flows and sedimentation occurring between the onset of the Flood and its marine inundation of the region.

The Kansas Midcontinent Rift Segment

The MRS is a regional basement feature extending in an arc from southeastern Michigan under Lake Superior and southwest into Kansas (Reed, 2000). The southernmost segment of the MRS disrupts the basement in eastern Kansas from Nebraska to Oklahoma, between the Central Kansas Uplift and the Nemaha Tectonic Zone (Figure 1). Its lithologic expression ranges up to 40 km (25 miles) wide and up to 8–9 km (~5 miles) in depth, although some geophysical data suggest a widening towards Oklahoma. Analysis of the seismic velocity and reflection data also suggested that the crust extends down to 45 km (28 miles) under the MRS.

The MRS is clearly seen on a Bouguer gravity anomaly map (Figure 2) with a strong positive (up to 6 mgals) that trends south, southwest from Marshall County at the Nebraska border to Ottawa County, and then in decreased strength south to Kingman County near the Oklahoma border. A very strong negative (down to –88 mgals) anomaly flanks the strong positive feature to the east and southeast; from Marshall County in the north to Marion County in the central part of the state (Lam, 1986). However, much of the gravity anomaly has been determined to be derived from deep-seated crustal intrusives rather than rift basalt flows.

The northern boundary of the Kansas Segment is separated in a left-lateral offset from the Iowa Segment by 80 km (50 miles) of granitic craton. Well data (Lidiak, 1972) and seismic data (Serpa et al., 1984) demonstrate a clear crustal separation between the mafic fill of the Kansas Segment and the Iowa Segment in Nebraska. The offset is a continuation of the geophysically-defined Missouri Gravity Low, a gravity anomaly trending northwest through Missouri into Nebraska (Van Schmus et al., 1993).

Early structural interpretation of COCORP seismic lines (Figure 3) suggested a basin formed by listric normal faults and rotating fault blocks, and filled with a lower group of basalt flows and an upper group of rift sediments (Serpa et al., 1984). However Woelk and Hinze (1991) reprocessed the upper portions of the COCORP lines and constrained their interpretation with data from the Texaco Noel Poersch well to derive a different rift model; one with reverse faults bounding the central rift fill of basalt and gabbro, displacing it over rift clastics of the Rice Series. This model is similar to the style of the MRS segments to the north. Woelk and Hinze (1991) also noted the presence of mafic intrusives beneath the rift in the lower crust. They interpreted the maximum rift depth as 9 km (29,528 ft), and the throw on the reverse faults as 3 km (9,843 ft).

Lam (1986) noted that gravity data show a clear extension of the MRS to the Oklahoma border, although direct data suggest that rift basalt terminates in central Kansas. He predicted a minimum of 1500 km^3 each of basalt and sandstone in southern Kansas. However, the 60 mgal gravity high (second order residual gravity) in north central Kansas abruptly decreases to a 20 mgal gravity high in Saline County. Lam (1986) explained this as the effects of the boundary between the more rigid northern granite terrane

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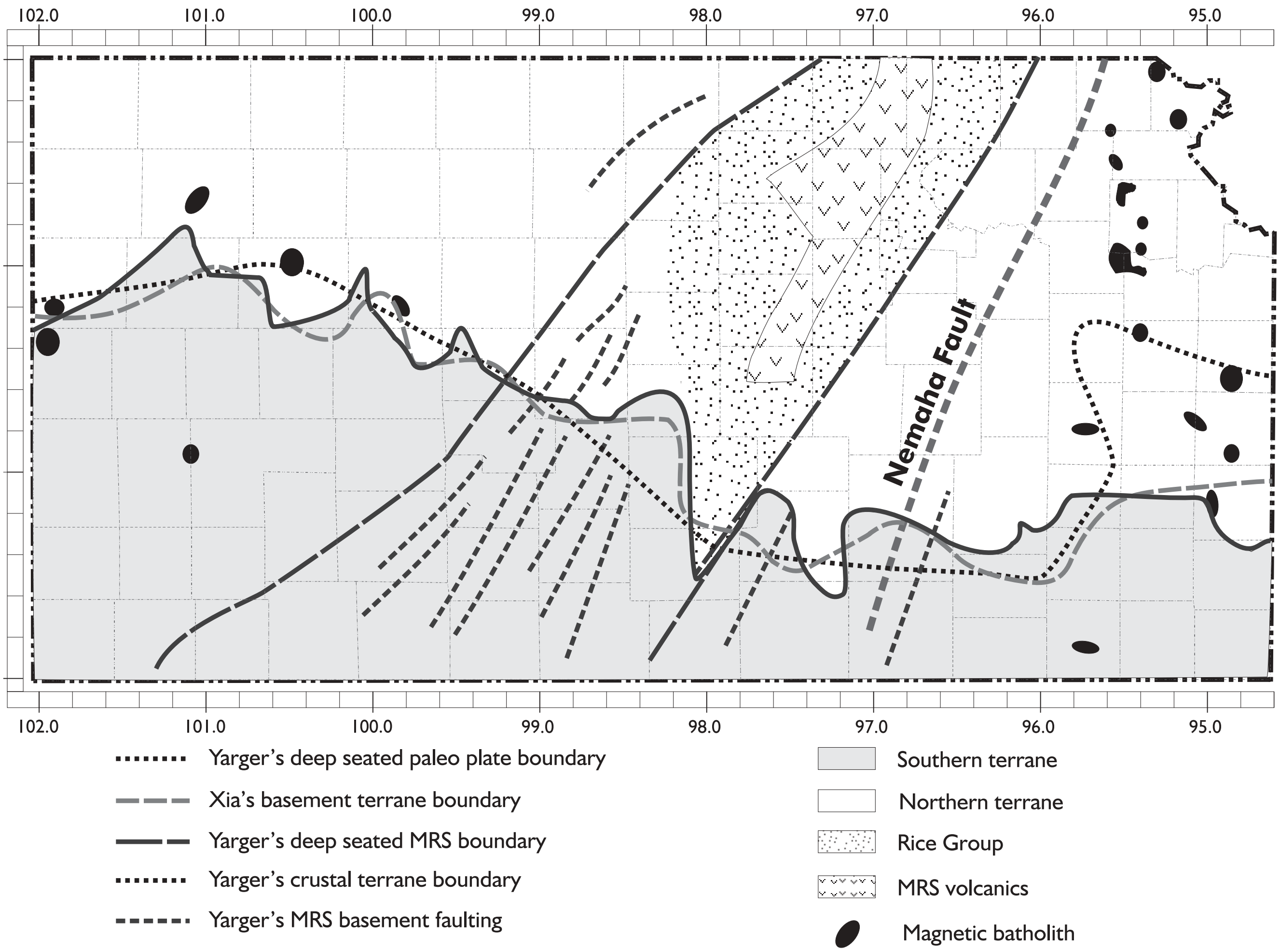

Figure 1. Basement terrane boundaries in Kansas. Modified from Yarger (1983) and Xia (1995).

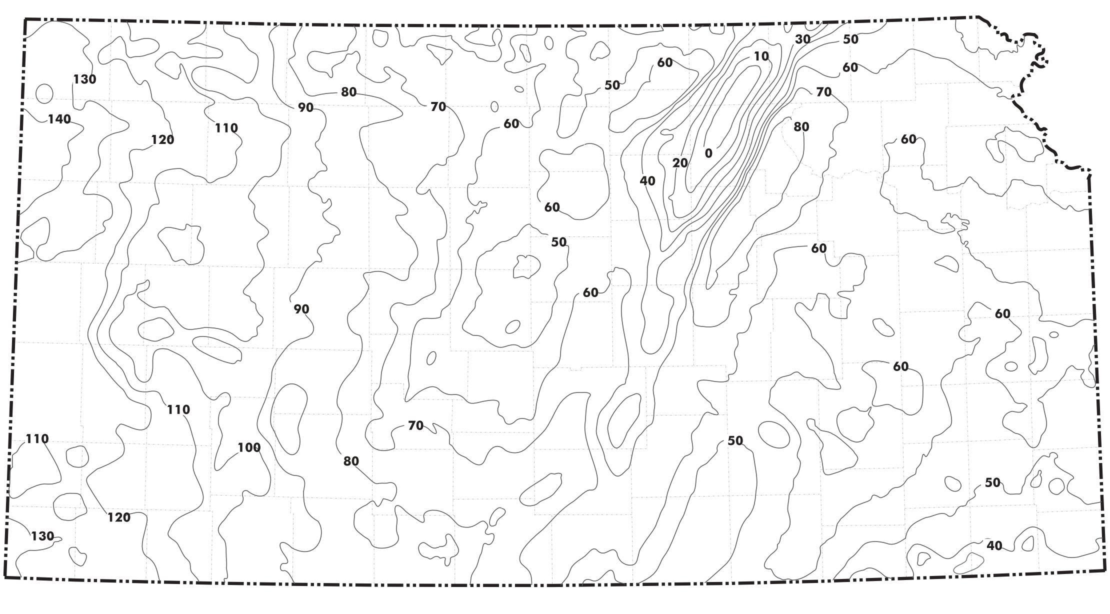

Figure 2. Bouguer Anomaly Map. After Xia et al. (1993).

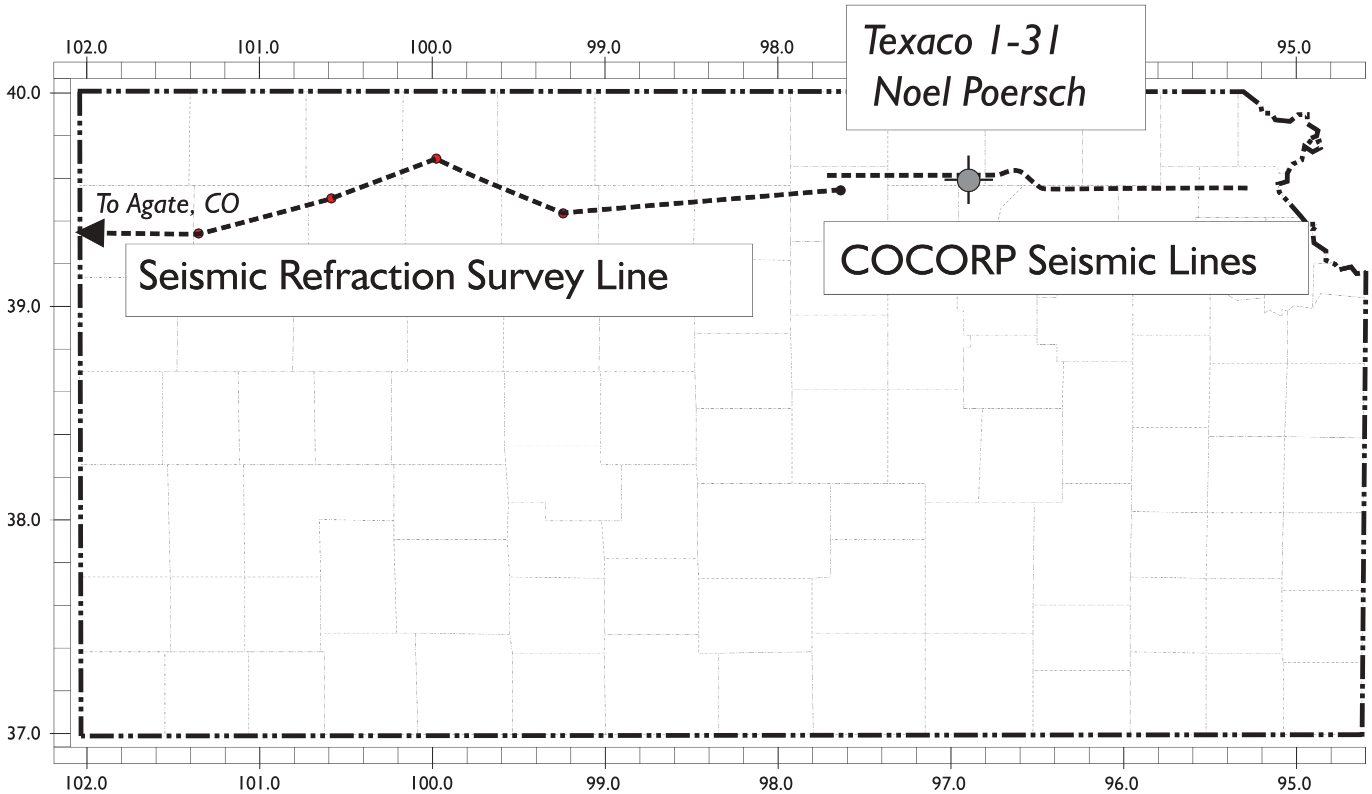

Figure 3. Location of COCORP seismic reflection and Kansas Geological Survey seismic refraction lines. After Berendsen et al. (1988) and Steeples and Miller (1989).

and the more ductile southern granite terrane cause by elevated geothermal gradient from the 1.4 Ga granite-rhyolite igneous event. He estimated a total volume of rift basalt and sandstone at a minimum of 36,000 km^3 and 16,000 km^3, respectively.

Yarger (1983) agreed that the MRS extends to the southern boundary of Kansas based on his interpretation of magnetic anomaly data. Magnetic data also support thick clastic fill associated with the rift. However, he concluded that the MRS in southern Kansas included only block faulting and igneous intrusions, the large-scale extrusive and sedimentary features of the northern Kansas rift being absent. Magnetic anomaly data also suggest fault boundaries of the MRS on both east and west sides and a relationship between the MRS and the Humboldt Fault.

The structure of MRS basins in Kansas appears more complex than other parts of the rift. Structural complexity results from the intersection of the Nemaha Tectonic Zone, the Abilene and Vorshell anticlines, and cross-cutting northwest-trending basement structural zones (Berendsen, 1997; Berendsen and Blair, 1992). The role of new data and interpretation is illustrated in a comparison between the relatively simple understanding conveyed in Bickford et al. (1979) map and a recent interpretation (Figure 4).

Berendsen (1997) shows Rice Series clastics occurring in flanking and horst top basins only in the northern area of the Kansas zone, but apparently covering volcanics at the Precambrian subcrop in the southern part of the Kansas Segment. In the northern area, the clastic basin is more extensive on the west side of the volcanic horst and was named the Rice Basin by Scott (1966). Atop the volcanics in the area of the Abilene Anticline, Rice Series clastics occur in a mosaic of small fault blocks and in a narrow strip to the east of the volcanics and west of the Nemaha Tectonic Zone (Figure 4B). No clastics occur in the Nemaha Tectonic Zone, although such sediments are found in fault-bounded basins in the granitic basement to the east of the Humboldt Fault (Berendsen, 1997), suggesting that the fault was possibly active during Rice Series deposition.

Rift Fill and Stratigraphy

The clastic fill associated with the MRS in Kansas has been informally termed “arkose” and “red clastics” (Koester, 1935) and “granite wash” (Mettner, 1936). Scott (1966) posited a distinct unit, which he termed the Rice Formation, based on 5,200 km^2 (2,007 $mile^2$) area in east-central Kansas. Although the base of the Rice Formation had not

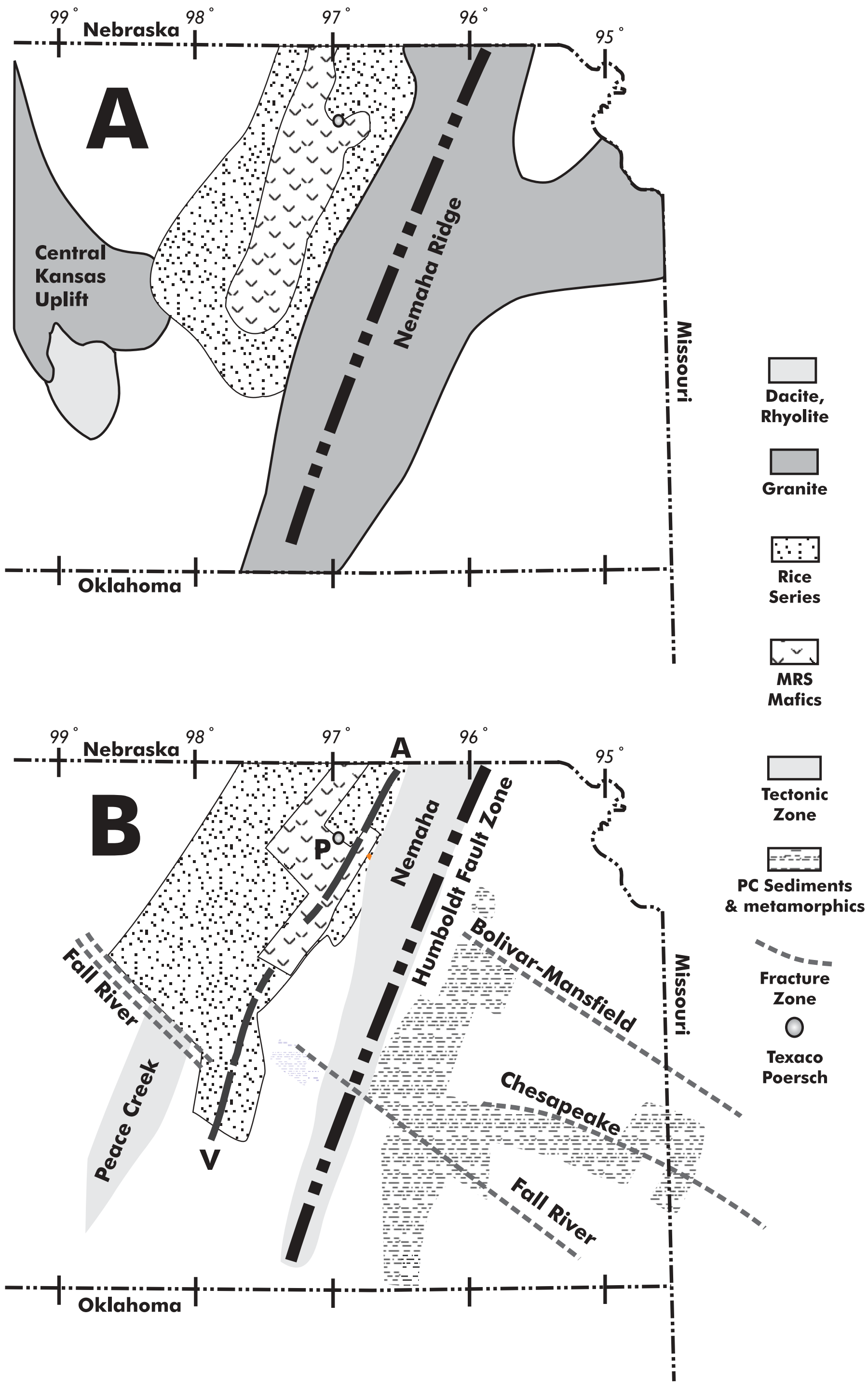

Figure 4. (A) Bickford (1979) basement interpretation at the Midcontinent Rift System as compared to that of (B) Berendsen and Blair (1992). A is Abilene Anticline, V is Vorshell Anticline, and P is Texaco Poersch well.

then been penetrated, Scott used cores from four different wells as a type section.

The Rice Formation was described by Scott (1966) as arkose to feldspathic sandstone with interbedded brown and green micaceous shale and dolomite cement. Occasional dolomite and limestone beds are present in the section. The Rice Formation was described in an area of eastern Kansas coincident with the MRS. Although there are numerous Precambrian penetrations by wells in Kansas (Cole and Watney, 1985), the depth of penetration in most wells is severely limited relative to the posited thickness of the unit, and there had been no real synthesis of the data until the drilling of thc Poersch well in 1985.

Berendsen et al. (1990) compared MRS sediments with overlying Cambrian clastics. These included formations found outside Kansas, the Low Rock Formation in Iowa, the Ironton Formation in Wisconsin, the Eu Clair Formation in Wisconsin, and the Mt. Simon Sandstone in Wisconsin. They concluded that it would be easy to distinguish MRS and Cambrian sandstones because of the pronounced angular unconformity commonly found between the two, the addition of glauconite and phosphorite faunal material, different types of sedimentary rock fragments, and mineralogy suggesting marine deposition.

Other workers disagree that the contact between the Proterozoic and Paleozoic sediments was clearly defined (Dickas, 1986). Also, it should be noted that angular unconformities are present between "conformable" units, such as the Oronto and Bayfield Groups at the margins of the Lake Superior Basin (Reed, 2000), and that considerable lithologic variation is encountered between sediments of similar age along the MRS. The relationship between lithologic variation and age appears uncertain.

The Rice Series is associated with the MRS. Delineation of the limits of that structural basin and the edge of the clastic fill is difficult, and done primarily by gravity and magnetic data, supported by well penetrations. However, wells penetrating the Rice Formation prior to 1966 may have used a variety of names to mark the

	Unit	Top (ft)	Top (m)	Base (ft)	Base (m)	Thickness (ft)	Thickness (m)	Composition
Upper Volcanic-Dominated Succession		**2,846**	**867**	**7,429**	**2,264**	**4,583**	**1,397**	90% igneous; 10% sediments
2e	Gabbro	2,846	867	3,150	960	304	93	intrusive mafic
2d	Basalt Sequence	3,150	960	4,140	1,262	990	302	layered basalt flows
2c	Upper Mixed Volcanic-Sedimentary Sequence	4,140	1,262	5,719	1,743	1,579	481	alternating basalt flows and arksosic clastics
2b	Basalt-Dominated Sequence	5,719	1,743	7,039	2,145	1,320	402	thicker, more altered basalt flows
2a	Lower Mixed Volcanic-Sedimentary Sequence	7,039	2,145	7,429	2,264	390	119	alternating thin basalt flows and arksosic clastics
Lower Sedimentary-Dominated Succession		**7,429**	**2,264**	**11,300**	**3,444**	**3,871**	**1,180**	90% sediments; 10% igneous
1e	Upper Sedimentary Sequence	7,429	2,264	8,806	2,684	1,377	420	fining up cycles of cong. - coarse arkose to siltstone
1d	Upper Mafic Unit	8,678	2,645	8,806	2,684	128	39	altered gabbro sill
1c	Middle Sedimentary Sequence	8,806	2,684	10,840	3,304	2,034	620	same as 1e, coarser, more variable grain size
1b	Lower Mafic Unit	10,622	3,238	10,840	3,304	218	66	altered thin basalt flows
1a	Lower Sedimentary Sequence	10,840	3,304	11,300	3,444	460	140	similar to 1c and 1e, coarser, more volcanic lithics

Table I. Sedimentary sequence of the Texaco Noel Poersch 1-31 Well in Kansas.

sediments, and if the contact between Paleozoic and Proterozoic sediments is difficult to pick, no differentiation may have been made between immature Paleozoic arkosic sandstones, relatively *in situ* granite detritus, and the Rice Formation.

Berendsen et al. (1990) discussed categories of Precambrian clastic rocks in Kansas. They classified them as Rice Formation, Hinckley Sandstone equivalents, Fond du Lac equivalents, and granite wash clastics. Granite wash is residual material resulting from the weathering and erosion of granitic basement. Accumulations vary from a few feet to several hundred feet (Cole and Watney, 1985). No age is assigned since the rocks are unfossiliferous and exposure of basement rocks is not limited to a particular time. They correlate the Rice Series sediments to the Keweenawan Chequamegon Sandstone in Wisconsin, the lower Mt. Simon Sandstone in Minnesota and Iowa, and the Red Clastic Series in Nebraska, based on lithology and relative stratigraphic position (Reed, 2000).

Sediments at the Poersch Well

A detailed description of Precambrian sediments in Kansas was developed from cores, cuttings, and logs from the Texaco 1-31 Noel Poersch well. It was drilled in southwestern Washington County, Kansas in 1985 on the east side of the MRS near the Kansas COCORP seismic lines. The well was drilled to a total depth of 3,445 m (11,302 ft), penetrating 868 m (2,848 ft) of Phanerozoic sediments before encountering a 1,397 m (4,583 ft) section of Proterozoic mafic volcanics and intrusives with minor sediments. Below this unit the well penetrated 1,180 m (3,871 ft) of predominantly arkosic clastic sediments with minor mafic units. Berendsen et al. (1988) described two major successions in the Precambrian section (Table I), each with five sequences, ranging from 39 m (128 ft) to 620 m (2,034 ft).

Sequences 1a–1e belong to the Lower Sedimentary-Dominated Succession, and sequences 2a–2e belong to their Upper Volcanic-Dominated Succession. The Lower Sedimentary-Dominated Succession consists of three sedimentary sequences divided by two thin mafic units. All three of these sequences consist of series of fining-upwards cycles of arkosic conglomerate and coarse-grained sandstone to finer sandstone and siltstone. Dolomite cement is locally present, and more common in sequence 1c. The coarser-grained clastics are generally subarkoses, while the quartz fraction decreases in the finer-grained sandstones and siltstones. Sandstones vary widely in sorting (poor to medium) and grain roundness. Rounded and frosted quartz grains are common in the coarser-grained rocks. Feldspars in the coarser-grained fraction are relatively fresh, light pink to salmon potassium feldspar. Feldspar alteration and hematite staining increase in the finer-grained rocks. Lithic grains are usually fresh volcanics. Coarser grain sizes are more common in the lower sequences, and volcanic lithic fragments are common in the lowest sequence. The increase of volcanic lithics downward through the lowest sequence suggests a lower volcanic source. Indications of fractures are present in the clastics. The lower mafic unit is composed of a series of thin alkali basalt flows, heavily altered to epidote and chlorite. The upper mafic unit if a dark green/gray fine to very fine grained gabbro, with common epidote and sulfide alteration.

The Upper Volcanic-Dominated Succession is described by Berendsen et al. (1988) from the base up (2a to 2e in Table I) as a mixed volcanic/sedimentary sequence, overlain by a basalt flow sequence, overlain by another mixed volcanic/sedimentary sequence, overlain by a basalt flow sequence, overlain by gabbro. The top of the gabbro is the erosional Ordovician unconformity, overlain by sediments of the Simpson Group. The mixed volcanic/sedimentary sequences consist of thin flows of alkali basalt, with oxidized and altered tops, interlayered with coarse-grained arkose to siltstone. The sandstone resembles "granite wash," an immature relict of granitic basement erosion, common in many locations across the cratonic interior. Berendsen et al. (1988) noted more extensive alteration of the basalt in the upper volcanic/sedimentary sections. Overlying each mixed sequence are basalt flows that do not contain any sedimentary interlayering. Although individual flows were difficult to discern, they appear thicker in the basalt sequences, up to 113 m (371 ft) in thickness. The basalt is microcrystalline, light to dark green/gray, with red staining at presumed flow tops, and mafic content increases downward through individual flows. Extensive hydrothermal alteration is common. The final sequence in the upper succession is a thick, green to black, fine to medium grained gabbro. The contact between the intrusive gabbro and the overlying Ordovician sediments is sharp, and the gabbro is relatively unweathered near the contact. The low density measured in this gabbro by well logs suggests that open fractures occur deep within the rock. Several thin pegmatites, composed mostly of quartz and potassium feldspar are also present in the upper succession.

Discussion

Background: Uniformitarian versus Biblical Natural History

Creationists must question the legitimacy of the entire natural history enterprise within the worldview of naturalism. An evaluation of natural history in the naturalist worldview demonstrates contradictions between its assumptions, methods, and conclusions (Reed, 2001). Ironically, these contradictions arise from a cloaked dependence on Biblical theology. Another significant weakness of naturalism is the conflict between its positivist epistemology and its assumption of the validity of uniformitarianism.

The nature of this conflict rests upon the recognition that "deep time" consists mostly of "dead time"—time with no evidence of its existence. The rock record does not contain billions of years of strata. Instead, the rocks represent mere dribs and drabs of time, strung together on the skeleton of uniformitarianism. Although naturalists purport to present a continuous record of earth history in the geologic column, the real rock record (physical evidence) is scanty relative to the inferred history. This lack of physical evidence clashes with naturalism's epistemological assertion of positivism, and within that framework the lack of physical evidence strongly suggests that an empirical natural history cannot be trusted.

Uniformitarianism presents another problem for naturalists. Being an attempt to force positivism on the unobservable past via extrapolation, natural history and natural science are merged. But extrapolation can only be done confidently if the template of the present can be precisely fitted to the data of the past. Uniformitarians must answer two questions:

(1) does the variety found in the "present" preclude the construction of a precise template? and
(2) does the evidence of the past fit whatever template can be fashioned?

In the 19th century, Charles Lyell was fighting an entrenched Biblical history. He required a minimum level of certainty for his approach that would overcome the cultural confidence in the Bible. Lyell solved that problem by means of a rigid uniformitarianism. But empirical evidence collected since then is clearly at odds with that approach. However, he won, and the evidence that undermines his position remains inconsequential to his disciples because they have ignored the true challenge of catastrophism. Unfortunately, the challenge has not always been presented in its full logical force because of an emphasis on developing a corpus of empirical data supporting the young-earth interpretation, rather than attacking the faulty assumptions of uniformitarian natural history. Given the logical flaws in naturalism, the data cannot provide a credible history based upon discrete particles of strata floating in a sea of unobserved and unrecorded time.

Correlative problems do not exist for creationists because history is ultimately controlled and recorded outside of nature and man. A precise and accurate accounting of time is provided by an infinite, eternal, unchanging God. His omniscience makes Him the ideal historian. And when this God chooses to reveal history to man, those gaps that He allows in our knowledge are not absolute, since He retains the "missing" knowledge. These historiographic facets of the Biblical worldview save the possibility of natural history, but only within a Christian framework.

Another, largely unrecognized problem with uniformitarianism is the implication of temporal invariability (Reed, 1998). If "the present is the key to the past" at any given point in time, then there must be a corresponding relationship between any two given points in the past via the Principle of Identity (i.e., if Present = Past1 and Present = Past2, then Past1 = Past2). If the present is the key to all points in the past, then all points in the past must bear a resemblance to each other as well as the present.

Aspects of the geology of the Kansas basement illustrate these challenges to uniformitarian natural history. There are discontinuities between inferred historical processes across time. There are processes that are not observed in the present. Finally, there are vast amounts of missing time, undocumented by physical evidence. When the evidence is examined carefully, an interpretation within the Biblical worldview is seen to be more fruitful than that of uniformitarianism.

The Kansas Basement versus Uniformitarian Natural History

Does the basement beneath Kansas support the corollary or temporal invariability? The uniformitarian interpretation of the upper Midcontinent region includes 700,000,000 years of crustal accretion between 1.8 Ga and 1.1 Ga (Van Schmus et al., 1993) represented by various geochemical differences in sparse samples of basement rock. This period culminated in a spurt of intense deformation, volcanism, and sedimentation that formed the MRS. These processes occurred over regional areas (cf. Figure 5). There are no widespread regions of continental crustal accretion occurring today. Following these events was a span of 550,000,000 years of no discernible activity, which in turn was followed by another 500,000,000 years of active sedimentation, erosion, and structuring. Although one could argue that the evidence warrants a different interpretation, let us grant the uniformitarian scenario for the sake of evaluating its internal coherence.

At face value, the historical sequence of the midcontinent basement violates predictions of uniformitarianism with respect to temporal invariability based on the regional, major discontinuities between various parts of the rock record. It is incumbent upon uniformitarians to explain how this region underwent such singular events, then (based on the physical evidence) remained quiescent for 550,000,000 years, then was deformed and inundated by another 500,000,000 years of Phanerozoic activity. Which aspect of this history does the "present" unlock?

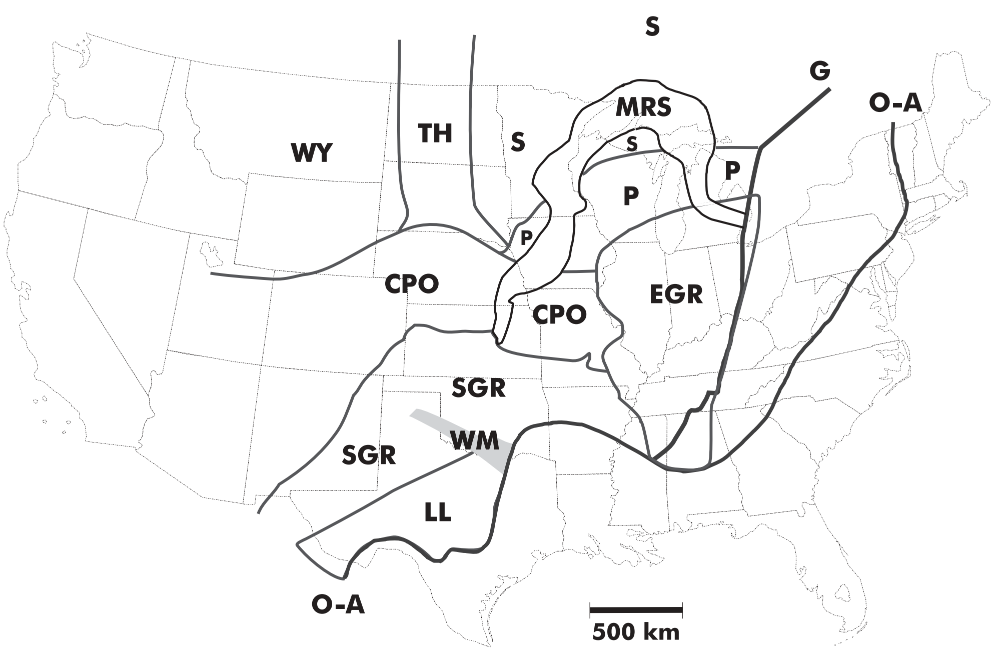

Figure 5. Basement provinces of the North American Midcontinent. S is the Superior province, W is the Wyoming province, TH is the Trans-Hudson orogen, CPO is the Central Plains Orogen, P is the Penokean orogen, EGR is the Eastern Granite-Rhyolite province, SGR is the Southern Granite-Rhyolite province, G is the Grenville front, MRS is the Midcontinent Rift System, LL is the Llano province, WM is the Witchita Magmatic province, and OA is the Ouchita-Appalachian front. Modified from Van Schmus et al. (1993) and Hinze (1996).

One of the more interesting features of the midcontinent basement is the 550,000,000-year unconformity between the eroded basement surface and Phanerozoic sedimentary rock (Reed, in press-a). This interval is defined in Kansas by its end points; the youngest sediments and volcanics of the MRS, circa 1050 Ma, and the earliest Cambrian sediments, circa 500 Ma. There is no rock record for the time interval, only an erosional surface. Thus, there is no empirical method of discovering or recounting that interval of history.

To place this problem in perspective, the hiatus is longer than the entire record of the Phanerozoic, which represents the vast majority of the regional sedimentary record between this hiatus and the ground surface. The problem is compounded in the uniformitarian framework; in addition to the missing evidence for this period, pre-Paleozoic sediments in Kansas are classified as non-marine (Van Schmus and Hinze, 1985) because of their mineralogical makeup, the lack of fossils, and the absence of associated marine beds. Thus, there is no evidence of a marine transgression during the hiatus. However, the same time interval in the Phanerozoic records at least six major transgressive-regressive cycles in the Midcontinent (Sloss, 1963). Similarly, evidence for plate tectonic cycles predicted by Hoffman (1989), and referenced by Anderson (1990) and Van Schmus et al. (1993) is missing. Hoffman (1989) predicted 200–300 million-year cycles. If the MRS is the result of one of these cycles, then why are there not two others observed in the 550,000,000-year hiatus?

Furthermore, dead time predominates even in those sections of the rock record that appear complete. Consider the presentation of stratigraphic charts in geologic publications. Comparing the scale of "deep time" against the page size of most publications, it is clear that hundreds of thousands or even millions of years can be compressed into the width of a line on the chart. On most stratigraphic charts, there is not even an effort to accurately portray the actual amount of time represented by strata. Why? Because the actual time of deposition is unknown, and also because if known, it is embarrassingly short relative to the stratigraphic interval. So history is blurred by two factors: (1) the inability or unwillingness to note that a purported "history" of several million years may depend on a thin layer of strata deposited in a very short time, and (2) the "scale masking" that takes place when the width of a line on the page is the equivalent of millions of years.

Reed (2000; in press-b) describes this problem with MRS volcanic flows. In Kansas, the MRS basalt flows observed in the Texaco 1-31 Poersch well occurred over a period of 23,000,000 years (Cannon (1994). The Poersch well logged 38 individual flows averaging 41 m (135 ft) thick over a 2361 m (7,746 ft) interval. Extrapolation over a suggested 8,000 m (26,247 ft) total thickness implies a total of 194 flows in the Kansas MRS. Evidence strongly suggests that individual flows could have formed in hours or days rather than over many tens of thousands of years. If the 194 flows formed over 23,000,000 years, and each flow occurred in less than one year, then each flow would commence on average following 119,000 years of inactivity. This simple illustration reveals that almost all of the history supposedly documented by the basalt flows is actually 99.99% "dead time" not documented by physical evidence.

If historical evidence must be tangible (as opposed to revelatory) then missing sections of the physical rock record are missing history. Since breaks in the historical record render it discontinuous, and the actual record is comprised predominantly of "dead time," the validity of the uniformitarian approach is severely compromised. Only the unsupported assumption of identity across time saves that version of natural history, and as mentioned before, that assumption is severely undercut by empirical data.

The Kansas Basement in Biblical Natural History

If uniformitarian natural history cannot survive its own weight, then how can the geological data pertaining to the Kansas basement be reinterpreted in the biblical framework of a young earth and global flood?

The most obvious features of the basement are the (1) lithologic discontinuity between the predominantly igneous and metamorphic basement and overlying sediments, (2) the widespread erosional contact between them, and (3) the tectonic disruption evidenced by the MRS. A rapid change from a continental to marine environment, deep erosion, and structural deformation are congruent with a Flood interpretation. With the exception of the MRS, the basement of Kansas can be interpreted as an erosional contact representing the basal Flood boundary. The occurrence of granite wash deposits in certain areas of the basement suggests local reworking of the newly-eroded granite and limited transport prior to preservation beneath regional marine beds.

Reed (2000) interpreted the MRS as a feature recording the very onset of the Flood. Its nonmarine sediments and volcanics represent the time between the tectonic initiation of the Flood and the arrival in Kansas of the marine transgressive front. Other igneous activity in the form of granite intrusions could have been associated with the same event, since it appears that some of the batholiths are genetically related to the downwarping of sedimentary basins, such as the Forest City Basin. Contrary to historical scenarios driven by isotopic dating, the physical evidence of a single igneous event, with both intrusive and extrusive components ties together the MRS, the granite batholiths, and basement structuring at the Nemaha Tectonic Zone. It is likely then, that large volumes of MRS volcanics and sediments were eroded, with the Rice Series, granite wash, and other pre-marine sediments representing the remnants of those pre-marine sedimentary deposits and the remaining basalt representing the remnants of more extensive flows.

Given such a Flood scenario, it is also possible that the granite wash, non-marine sediments of the Rice Series, and the basal Cambrian sandstones all are derived from the same source and represent different depositional situations occurring simultaneously. They would thus be distinguished by their depositional parameters and not by uniformitarian history. Thus, these sediments could have been deposited within a short timeframe. Rather than indicators of time, they represent a continuum of sedimentary maturity (and the marine overprint on the Cambrian sands) with granite wash at one end and the basal Cambrian sandstones at the other. If so, then the links between these sedimentary deposits would span the basement unconformity and provide another indication that the 550,000,000 missing years never existed.

Sparse data from the basement are supplemented by the uniformitarian assumptions of isotopically dated terranes and provinces and their historical emplacement by plate tectonic processes. For creationists, the resulting elaborately constructed basement history would be largely irrelevant to a diluvial interpretation. The variations in basement lithology, chemistry, and isotopic ages may be a relict of creation, the result of antediluvian processes, or the tectonic processes operating at the onset of the Flood. The presence of rhyolite fields across stretches of the Kansas basement and the granitic intrusions would probably fall into the latter category.

In a diluvial model, the regionally scoured surface of the basement would serve to illustrate the erosional power of the Flood. The underlying rocks might be of interest to those creationists who might wish to reconstruct or earliest Flood events (e.g., Reed, 2000). In this model, the irrelevance of isotopic dating as currently applied would support the conclusions of Woodmorappe (1999). Given the estimated depth and extent of erosion of the basement, it is unlikely that any antediluvian strata were preserved.

Thus, all strata atop the eroded basement (along with the MRS) can be classified as either Flood or post-Flood deposits. This would mean that any antediluvian faunal communities would have been eroded, displaced, and redeposited. Fossiliferous strata between the basement and the ground surface represent processes of chemical precipitation, transport, and deposition. It is not possible in this paper to determine the scale limitations of such transport (e.g., of fossil reef blocks).

It seems likely from the erosion of the granite surface itself and the estimates of eroded basalts of the MRS, that significant erosion occurred between the onset of the Flood and the deposition of initial marine sediments. Based on the location of feeder dikes near the Lake Superior Basin, it is estimated that up to one half of the original basalt flows associated with the MRS were eroded. As noted by Reed (2000), such widespread and intense erosion during some part of the first 40 days of the Flood would certainly qualify as "catastrophic."

Examination of the Kansas basement offers the opportunity of an alternate interpretation within the framework of the Biblical worldview. One method of interpretation within this worldview is by reference to the relative levels of geologic energy that can be inferred from various features (Reed et al., 1996). A regional interpretation of the MRS within this context (Reed, 2000) attributed the MRS to the abrupt energy increase that marks the onset of the Genesis Flood (Figure 6). Does this interpretation appear sound in Kansas?

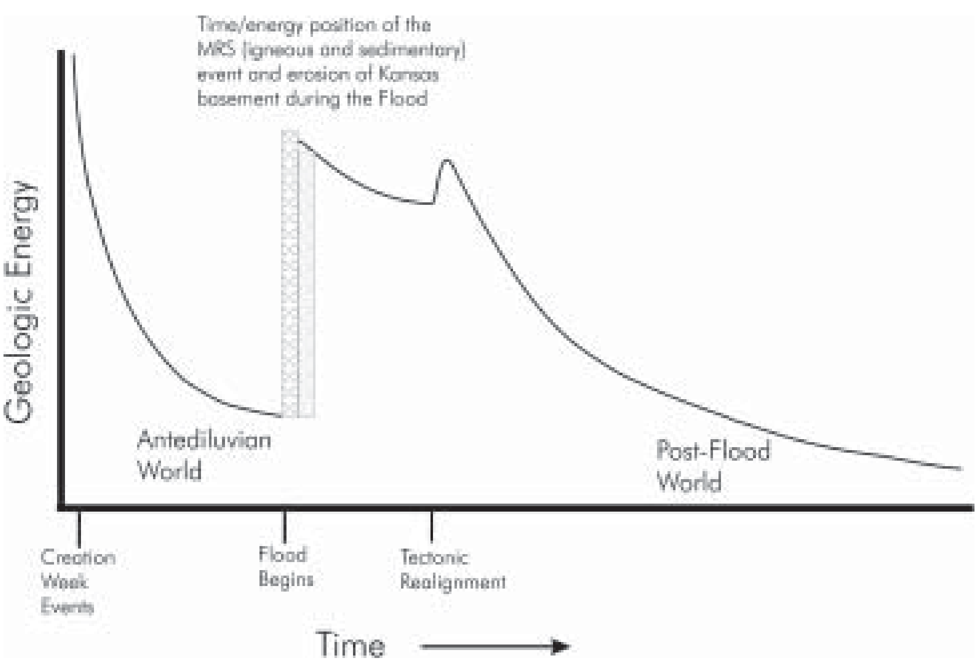

Figure 6. A graph of geologic energy versus times showing the location of the Midcontinent Rift System relative to the Genesis Flood. From Reed (2000).

If the basement in Kansas represents the results of an igneous and tectonic event of short duration, then the associated energy must have been quite intense. It would include the additive energy of structural uplift (e.g., Nemaha Tectonic Zone), igneous intrusions of granite batholiths and mafic bodies, igneous extrusion of MRS volcanic flows and rhyolite fields, and the subsequent development of cratonic basins (Anadarko, Salina, and Forest City). Intense rainfall prior to marine transgression could have resulted in severe erosion of the granitic basement and MRS rocks prior to the erosive power of the marine front. Structural deformation would also have weakened areas of rock, making them more susceptible to erosion. This would be particularly true as large areas of granite were uplifted, resulting in exfoliation. Finally, the Flood marine front would have resulted in additional erosion via large scale waves prior to the redeposition of basement-derived clastic sediments.

Origin of Phanerozoic Basins

The relationship between Precambrian basement features and Phanerozoic basins assumes a radically different nature in a catastrophic framework. Rather than a complex system of repeating cycles of structuring, quiescence, and reactivation, a Flood model would recognize that structuring would be a logical outcome of tectonic activity at the onset of the Flood. Thus, events that uniformitarians place hundreds of millions of years apart would actually be relatively simultaneous and possibly be related. Thus the formation of the MRS, the Central Kansas Uplift, the Nemaha Tectonic Zone, the Forest City Basin, the Salina Basin, and other similar features would all be tied together at the Flood onset. This would alleviate some of the genetic problems that baffle uniformitarians.

It is commonly difficult to interpret these features. Most are known from structures in the overlying Phanerozoic rocks, and it is seldom clear whether these reflect Phanerozoic deformational structures, structures resulting from topographic features on the basement surface, or reactivation of Precambrian structures.

In general, because of poor detail in subsurface control, we have not found good correlation between the known geology of the Precambrian basement and location of younger structures. For example, the Nemaha uplift of eastern Kansas, Oklahoma, and Nebraska, a major basement feature, does not correspond to any identifiable lithologic or age-province boundary defined by petrography or geochronology. Moreover, it has virtually no geophysical expression on either gravity or magnetic maps of the region. (Van Schmus et al., 1993, p. 241).

Marshak et al. (2000) note that the late Proterozoic to Eocambrian in North America was a time of intense structural and magmatic activity. If the uniformitarian timescale is ignored and the timing of this activity is reconsidered to be prior to widespread Phanerozoic sedimentation, then a Flood model would take the same evidence and conclude that there was a burst of tectonic and magmatic activity prior to Flood sedimentation. Such an interpretation would agree with the implications of the biblical description of the Flood onset and would provide a basis for linking these features across North America. The search for genetic links between basement tectonic and magmatic features such as the Wichita Magmatic province in Oklahoma and Texas, the MRS, the Nemaha Tectonic Zone, and cratonic basins opens a new area of potentially fruitful research for creationist geologists.

Conclusion

The basement of Kansas has been determined, by a variety of indirect techniques, to consist of predominantly crystalline rocks, divisible into two terranes. Interrupting the primarily granitic basement is the Kansas segment of the Midcontinent Rift System, noted for its mafic intrusive and extrusive rocks and continental clastics. Interpretation of these features within uniformitarianism emphasizes isotopic dates and plate tectonic processes. A more satisfactory interpretation is found within the context of the Genesis Flood.

In summary:

- crystalline basement and terranes in Kansas are eroded pre-Flood continental rocks
- the earliest marine sedimentary deposits (Cambrian) in Kansas represent the initial marine transgression of the Flood
- the earliest non-marine sediments (i.e., Rice Series, granite wash, undifferentiated sediments east of the Nemaha Tectonic Zone) are probably non-marine relicts of pre-marine Flood activity
- a contemporaneous origin and causal links for events considered widely separate in time by uniformitarians can be explored by creationists
- the short time frame for the Flood demands interpretation of geologic features in light of tectonic and depositional processes rather than time

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"Everything about the origin of life on earth is a mystery, and it seems the more that is known, the more acute the puzzles get. …The chemistry of the first life is a nightmare to explain. No one yet has devised a plausible explanation to show how the earliest chemicals of life … might have constructed themselves from the inorganic chemicals likely to have been around on the early earth. The spontaneous assembly of small RNA molecules on the primitive earth 'would have been a near miracle.…'"

—Nicholas Wade. Life's Origins Get Murkier and Messier. "Science Times" in the *New York Times*, June 13, 2000