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The Bible has served as a source of spiritual inspiration for many centuries. It has been used as a text in the academic disciplines of history, geography, archeology, literature, law, language, and health, as well as in theology. Yet this multipurpose manuscript has been virtually ignored as an earth science reference. It is this writer's intent to demonstrate the Bible's value as a geological resource. Until this century the geological community lacked a paradigmatic base. How could one interpret Biblical geology if one could not interpret modern geology? Mysteries began to unfold with the general acceptance of the hypothesis of Continental Drift. Now the geological lessons contained within the Bible are also becoming apparent.

Early Twentieth Century geologists believed that the earth had formed from a molten state and was still in the process of cooling and contracting. The heavier elements had settled to the core while the lighter materials remained on or near the surface forming the Earth's crust. The process of contraction was deemed responsible for squeezing the Earth's surface into mountain ranges and ocean basins and also causing the innundation or emergence of land. It was believed that the presence of similar fossils on distant continents were due to the existence of land bridges before submergence and the continents were thought to be fixed (Hallam, 1975, pp. 90-91). This brief outline above comprised the interpretive basis for geological data in the early nineteen hundreds.

In 1912 a German meteorologist, Alfred Wegener, became the first major proponent of the hypothesis of Continental Drift. Wegener, as others before him, first conceived the idea of moving continents while contemplating the matching of continental coastlines. He noted flaws in the traditional view in explaining the position of distinctive geological features, the geographical location of the same or similar fossils and the orientation of similar types and ages of rocks on separate land masses. In attempting to correct the contradictions and inconclusive explanations, Wegener reviewed the Continental Drift Theory that suggested that the Earth's land mass was once a single, supercontinent Pangaea, floating on a denser substrata. Thus, horizontal as well as vertical land movements were possible. While reorienting the continents and noting the distribution of coal, tillite, and salt deposits, Wegener proposed that drastic climatic changes had occurred since the time of Pangaea and the continents had moved in their positions relative to the north and south poles.

Wegener's weakest point, on which he was severely attacked, concerned the mechanism that caused drifting. Wegener concluded that tidal forces related to the Earth's rotation were responsible. Further investigation using the Continental Drift Theory and the discovery of a more plausible drifting mechanism have elevated Wegener's theory to the present geological paradigm.

As the term Pangaea implies, today's continental plates were once connected and surrounded by a universal ocean. The northern and southern portions were attached on the west between North America and Africa while a large opening, the Tethys Sea existed, separating Africa and Eurasia on the east (Fig. 1). Approximately 200 million years ago, the land began to tear apart, or rift, because of lateral and rotational motion. However, not all sections have been equally active. By the end of the Triassic Period (180 million years ago), the Atlantic and Indian Oceans had started to form. The northern section, consisting of North America and Eurasia, began drifting northwestward while rotating clockwise about a point now in Spain. South America and Africa became separated from Australia, the Antarctic, and India (Dietz and Holden, 1972, p. 108).

FIGURE 1—Dietz and Holden, 1972, p. 106.

During the Jurassic Period (136 million years ago) the eastern end of the Tethys Sea continued to close. At this time a rift also developed between South America and Africa with their complete separation by the end of the Cretaceous Period (65 million years ago) (Dietz and Holden, 1972, p. 108).

At the end of the Cretaceous Period, Africa had drifted northward with a counterclockwise rotation. The Eurasian plate remained slowly rotating clockwise. These two opposing motions nearly closed the eastern end of Tethys. About the same time a branch of the Indian Ocean rift split Arabia from Africa (Dietz and Holden, 1972, p. 111).

The separating of Arabia from Africa during the latter part of the Cenozoic Era is an excellent example of drifting land masses. The results of this massive crustal separation produced the Gulf of Suez, the Red Sea, and the Gulf of Aden. The first indication of Arabia's movement relative to Africa was the near parallel position of faults on the Arabian side of the Red Sea to those on the African coast down to the Afar volcanic lowlands and continuing eastward along the Somalian coast to Socotra (Fig. 2). The identification of structurally corresponding points (1-(1), 2-(2), etc.) indicates the results of this movement. In comparing the gradual widening of the Red Sea depression to the more rapidly moving Gulf of Aden depression, a 6 or 7 degrees counterclockwise rotation of Arabia relative to Africa is suggested. There is further evidence of drifting: (1) Crustal separation should be accomplished with little or no subsidence and a deep fissure should develop from the point of separation. As the fissure widens, intrusive material should fill the depression and can be detected by a positive gravity anomaly when geologically surveyed. This has been confirmed; (2) Basic rocks should be present in the depression and the absence of continental material should be noted. Seismic explorations of the region concur; (3) The sides of the Arabian block parallel to the direction of movement should be wrench faulted. This phenomena did occur and has produced the Dead Sea Rift from Aqaba to the Galilee (Holmes, 1965, pp. 1078-1081).

This brief explanation of Continental Drift has concentrated on the regional formation of the Holy Land. In determining the total effect of continental drift and tectonics upon Biblical history, it is imperative to concentrate on the specific land involved. An indepth treatment of this topic would dictate a detailed geological analysis of the Tigris-Euphrates area, Egypt, the Sinai peninsula, Israel, and Jordan. Since the purpose of this paper is to introduce a possible geological interpretation of Biblical descriptions, Joshua will serve as an illustration and only the Dead Sea area will be discussed.

It is believed that the Arabia-Sinai-Palestine land mass began separating from Africa as early as the Jurassic Period. This continual con-

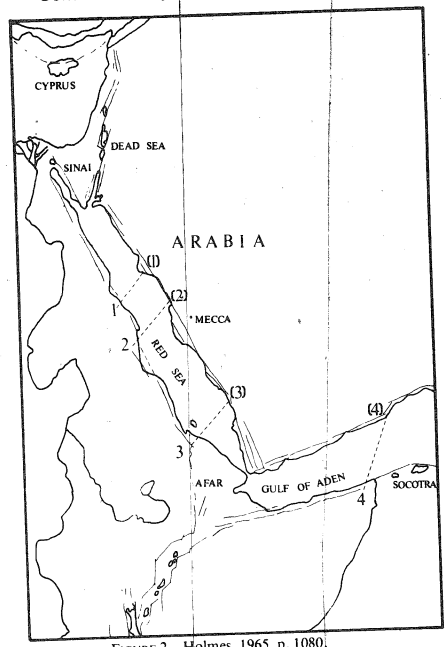

FIGURE 2—Holmes, 1965, p. 1080.

tinental separation produced a major strike-slip fault which, ultimately, formed the Dead Sea Rift zone. The Dead Sea Rift involves two distinct phases of movement. The first, initiated by a WNW-ESE compressional stress, caused a horizontal displacement of 62 Km and a 3 degree rotation with counterclockwise swing of the Arabian block relative to the Palestine (Quennell, 1958, p. 10) (Fig. 3, Stages A to B). Major folds, monoclines, wrench faults and transverse faults are evidence of this first movement. A period of quiescence followed during the Oligecene Epoch (40-25 million years ago). The second phase of movement commenced during the lower Miocene Epoch (25 million years ago) and resulted in an additional displacement of 45 Km accompanied by a rotation of 2½ degrees (Fig. 3, Stages B to C). Earlier faulting and folding patterns were followed with a slight reorientation of stress, NW-SE. Sustained stress caused shearing which, ultimately, formed the rift (Quennell, 1956, pp. 396-398). The Dead Sea area is a gap whose cross faults widen with each

horizontal movement along the rift. Earthquakes and vulcanism can be expected since this second phase is still considered to be in progress. Evidence for this conclusion is found in the modern fault-trace features in the rift floor and in the frequent recurrence of earthquakes within historic times (Quennell, 1958, p. 18).

Different types of igneous activity are associated with the Dead Sea Rift. The basalt flow of the Hauran in southern Syria covers a large area. The flows have also been traced to the northern part of Lake Tiberias and into Galilee. Fissure eruptions have also occurred at Jebel Shinan resulting in small flood basalts (Fig. 3).

The presence of volcanic cinders in the vicinity of the small breached cone of Jebel Uneiza, southeast of the Dead Sea, indicates vulcanism of a more violent nature. The Wadi Zarqa area has several vents and contains the youngest known flow - late Pleistocene Epoch. It probably occurred during the last great horizontal displacement along the rift. Hot springs are still found in the area (Quennell, 1958, pp. 15-16).

The only recorded evidence of activity within the rift is at Grain Sabt in the Jordan valley, where an olivine-basalt laccolith has been exposed by erosion. It is believed to be mid-Pleistocene in age and associated with the second phase of movement (Quennell, 1958, p. 18).

Thus the Biblical Israelites lived on an active rift zone, susceptable to earthquakes resulting from movement along the existing faults, and to volcanic activity. However, the ancients considered all natural phenomena the "Will of God". Had the Israelites possessed the knowledge of basic geological principles, the instrument of "God's Will" could have been better understood.

As an illustration, a "miracle" occurred as Joshua and the Israelites prepared to cross the Jordan River into the Holy Land:

> "The waters which came down from above stood, and rose up in one heap, a great way off from Adam, the city that is beside Zarothan; and those that went down towards the sea of Arabah, even the Salt Sea, were wholly cut off; and the people passed over right against Jericho. And the priests that bore the ark of the covenant of the Lord stood firm on the dry ground in the midst of the Jordan, while all Israel passed over on dry ground, until all the nation were passed clean over the Jordan." (Joshua, IV, 16-17)

Earthquakes have been known to collapse portions of the high clay cliffs beside the Jordan River effectively damming its flow. One such occurrence was in 1927. During severe earthquake activity, the high west bank just below the Jir el Damieh ford collapsed and fell across the river blocking its flow for 21½ hours. Witnesses said that they crossed the dry riverbed several times (Garstang, 1931, p. 137).

It is possible that an earthquake was responsible for temporarily damming the Jordan River and enabling Joshua's people to cross on the dry riverbed.

There is additional support for this hypothesis. There is evidence for

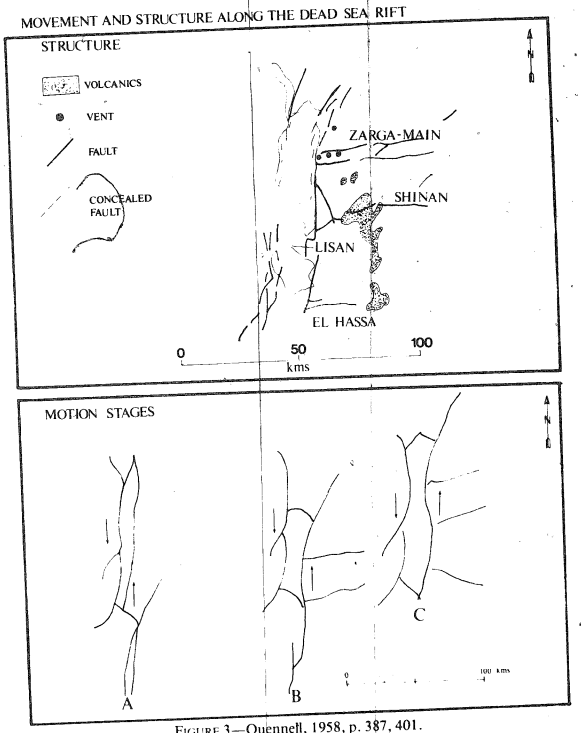

FIGURE 3—Quennell, 1958, p. 387, 401.

tectonic activity in the Biblical period prior to Joshua. The Bible states that "Mount Sinai was altogether on smoke, because the Lord descended upon it in fire; and the smoke thereof ascended as the smoke of a furnace, and the whole mount quaked greatly" (Exodus, XIX, 18). The Song of Deborah, reporting on the Israelite journey through Sinai, tells us that "when Thou didst march out of the field of Edom, the earth trembled" (Judges, V, 4).

Along with earthquakes, vulcanism can also be expected during rift movement. The Bible confirms this notion by stating that "the Lord caused the rain upon Sodom and Gomorrah brimstone and fire" (Genesis, XIX, 24).

Once again tectonic activity was to come to the aid of Joshua: this time at Jericho.

> "And it shall be, that when they make a long blast with the ram's horn, and when we hear the sound of the horn, all the people shall shout with a great shout; and the wall of the city shall fall down flat, and the people shall go up every man straight before him." (Joshua, VI, 5)

During the earthquake of 1927, violent shocks were felt in Jericho for almost a week. Fatalities occurred when a hotel collapsed. Jericho is located on or near several zones of crustal weakness. The story of its ancient tumbling wall as a result of a severe quake is a distinct possibility. Archeologist John Garstang examined Jericho's ruined early Bronze age walls. The stones of the outer ring had fallen outward and downhill, but the inner wall along the crest of the hill had fallen inward. To this writer, it appears that the inner walls had fallen against gravity and must, therefore, have been pushed in by seismic waves. The walls also showed evidence of several large cracks and fissures. (Keller, 1964, p. 153)

Garstang later wrote, "Further investigation at Jericho in 1931 disclose the possible effects of earthquake shock affecting particularly the western wall, but not affecting the northern and southern walls. The eastern wall is entirely destroyed. These observations indicate tremors east and west across the rift, as was apparently the case in the earthquake of 1927-1928." (Garstang, 1931, p. 104)

In summary the Bible depicts a period of tectonic activity. The Bible also contains eyewitness accounts of actual geological phenomena, the damming of the Jordan River and the destruction of the walls of Jericho. The Bible cites many such occurrences that can be attributed to natural events and should be investigated in the light of Continental Drift. The Bible can serve as a valuable regional journal of geology.

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Annotated Bibliography Of Field Trip Research

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Introduction

Writers, analyzing research, often comment about the lack of reports with respect to field trips. These writers, as indicated by their references, seldom report more than two or three sources pertaining to field trips. However, numerous objective studies of field trips have been conducted, and many areas of education have been involved. The science disciplines, especially earth science, biology, and elementary science, have been studied on many occasions. Also, the field trip has been researched at all levels from the elementary school through college. Many of the studies have been conducted for the purpose of completing advanced degrees.

The purpose of this paper is to provide a comprehensive annotated bibliography of the kinds of objective studies that have been done with respect to field trip research. The references should be of service to graduate students doing literature searches, professors teaching graduate and undergraduate education classes, and public school educators who want to know more about the use of the field trip in education.

Of the forty-three references, twenty were found in journals, six were taken from *Dissertation Abstracts*, fifteen were dissertations, and two were master's studies. Primary sources were used where funds and time would permit. Several of the citations were located through published bibliographies and journal articles in which the author was attempting to analyze research reports. Most of the research references were discovered in the extensive bibliographies of unpublished dissertations. Source documents were then located, read, and annotated. Computer printouts from ERIC were obtained but not found helpful in locating field trip research reports.

This bibliography is a compilation of many types of field trip research. No effort has been made to be selective other than to include as many different types of studies as possible. The list is certainly not exhaustive, but it should help to assure that educators will have more ready access to field trip research.

References have been grouped by four categories: college, secondary school, elementary school, and other. The group labeled *Other* includes two studies that cut across all levels and two studies in which the authors did not indicate the level.

It was difficult to select a format for the abstracts because some researchers only list findings, others only list conclusions or state conclu-