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ORIGIN OF THE CHERTS IN LIMESTONES OF THE CHASE GROUP (LOWER PERMIAN), KANSAS

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INTRODUCTION

The origin of chert is one of the major subjects of controversy in sedimentology and geochemistry. Theories that explain the formation of chert have been proposed and discussed by numerous writers (Tarr, 1917, 1926; Dean, 1918; Van Tuyl, 1918; Richardson, 1919; Brydone, 1920; Sargent, 1929; Taliaferro, 1934; Keller, 1941; White, 1947; Xia, 1965; Peterson and von der Borch, 1965; Eugster, 1967, 1969). The conclusions reached by individual authors are incompatible and the derivation, concentration and introduction of the silica are not well understood. The limestones of the Chase Group (Lower Permian) in Kansas are a prominent topographic feature in the Flint Hills and associated with abundant cherts (Moore and others, 1951; O'Connor and others, 1968). It may be worthwhile to study these cherts in the light of verifying the theories that can be applied for interpreting their origin.

ORIGIN OF CHERT

A great many papers have been written regarding this subject. It is impossible to review them here. Tarr (1917, 1926), on the basis of a study on the chert in the Burlington limestone, concluded that the chert beds and nodules are primary chemical precipitates. Van Tuyl (1918) listed eight evidences favoring the conclusion that formation of chert is due to replacement. Keller (1941) based on

petrographic evidences from a study of Rex Chert concluded that the greater part of the Rex Chert was formed as a primary deposit supplemented by a considerable but quantitatively indeterminate amount of diagenetic replacement. More recently Eugster (1967) postulated a process for the formation of bedded cherts, based on precipitation of magadiite [$NaSi_7O_{13}(OH)_3 \cdot 3H_2O$], and subsequent leaching of sodium by percolating ground water. The above examples are by no means conclusive. Extensive bibliographies can be found in literature. It is obvious, however, that the problem of the origin of chert is not yet solved. The source of silica and the time of deposition are even less understood.

SOURCE OF SILICA

The source of the silica from which chert beds and nodules were deposited is an important consideration in explaining the origin of the chert. Tarr (1917, 1926) postulated the accumulation of silica gel from sea water or the ocean floor. The silica was derived from the land through ordinary processes of chemical weathering. Bramlette (1946) concluded that most of the porcelaneous and cherty rocks of the Monterey formation were formed through an alteration that consisted largely of a rearrangement of the silica of originally diatomaceous deposits. Other sources include silica-rich waters of volcanic, magmatic (Sargent, 1929), or hydrothermal (Lovering, 1962) origin. More recent

theories of the source of silica in sediments include silica liberated by diagenesis of clay minerals (Towe, 1962), by chemical dissolution of detrital quartz and perhaps other silicate minerals (Peterson and von der Borch, 1965), by pressure solution of silicates (Thompson, 1959) and by carbonate replacement of detrital silicates (Walker, 1960).

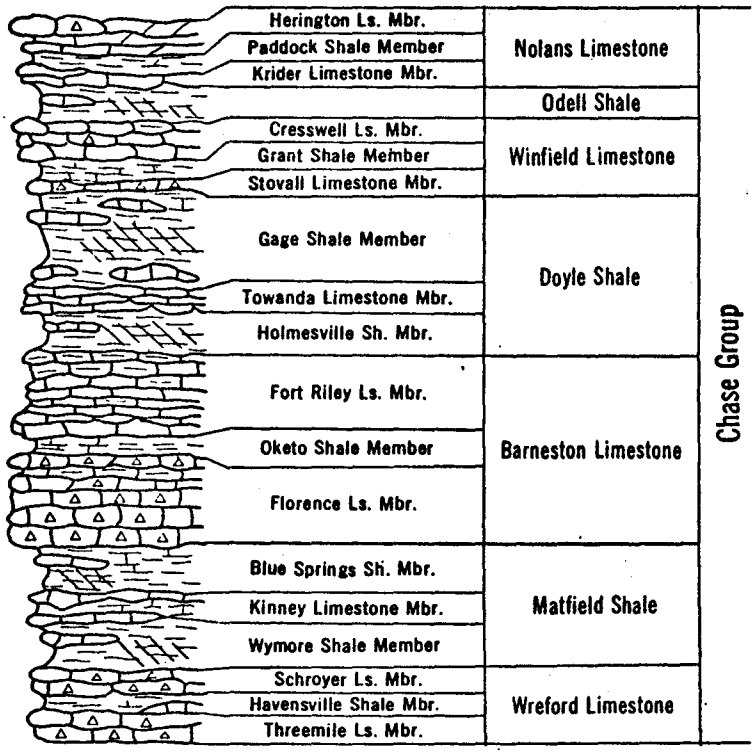
CHERT IN THE CHASE GROUP

The Chase Group is made up of about 335 feet of escarpment-making limestone alternating with shales (O'Connor and others, 1968). Ten limestone members are recognized in this group. Six of them are chert-bearing (Fig. 1). Only the cherts in the lowermost two limestone members (Wreford Limestone Formation) have been discussed in the literature. Twenhofel (1919) was probably the first to study the cherts in Wreford Limestone. The following conclusions were made by Twenhofel (1919) mainly from the study of the outcrops in the vicinity of the state line of Kansas and Oklahoma:

(1) It is possible that these cherts developed through direct precipitation of silica in solution in the sea water, but it is not believed that the facts support such origin. That some silica may have been added to the nodules from silica in solution in the sea water is considered quite possible.

(2) The chert is believed in major part to have resulted from replacement of unconsolidated limestone, the silica being derived from silica in solution which was mingled with the sediments, from silica in solution in the sea water, and from solution of organic or other silica, or silicates deposited in some form with the sediments.

(3) The suggestion is made that the banded nodules occurring in one of the zones may have had an algal origin, but no microscopic structures similar to those occurring in algae have been found.



Vertical Scale: 1 inch = 75 feet.

Figure 1. Rock Column of Chase Group (Gearyan Stage, Lower Permian Series) in Kansas.

On the basis of field observations, Hattin (1957) listed eight features to favor that "at least" the noncalcareous chert of the Wreford Limestone is of primary origin. He stated that the widespread geographic distribution of the cherts, both in surface and subsurface sections, and the constancy of lithologic association are not satisfactorily explained by theories of secondary chert formation.

The above interpretations on the origin of the cherts in the Wreford do not agree with each other; Twenhofel (1919) favored a penecontemporaneous origin for the chert; Hattin (1957) favored primary origin.

PLAN OF RESEARCH

Field Work. Preliminary work for this investigation will be field observations and sample collection. The latter includes not only the collection of chert samples but also the limestone samples as well. Field observation will emphasize the study of the areal distribution of the cherts, the forms of the chert and the field relationship of the chert to the limestones.

Laboratory Work. Laboratory work will include petrographic and chemical studies on cherts and associated limestones.

(1) Petrographic Studies: To study textural and mineralogical variations of cherts and limestones, and determine the relationship between chert and adjacent limestones. Instruments used will be X-ray diffraction equipment,

petrographic microscope, cathodoluminescence microscope, and electron microscope.

(2) Chemical Studies: To study the distribution and concentration of trace elements in the chert and limestone. Instruments used for performance will be atomic absorption spectrophotometer, emission photometer, flame photometer, and X-ray microprobe.

EXPECTED RESULTS

It is hoped that the information gathered from this investigation by various techniques may aid to determine:

(1) Whether there is any genetic relationship between the distribution of the chert and the lithology of the limestone.

(2) The source of the silica that forms the cherts.

(3) Whether the formation of the cherts in the limestones of the Chase Group are monogenetic or polygenetic.

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