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## Genesis of Certain Cherts

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all been singularly indecisive in results. The extraneous sources of error have not been guarded against. Far too much has been assumed. Not only has the work been not determinative, but in the published accounts the most important point of all, that of the geological conditions, has been scarcely ever touched upon.

To be sure, problems of this kind are beset with many difficulties. Many factors have to be taken into consideration. There are theoretical conditions imposed that have to be fully satisfied before actual examinations can be of much value. Singularly enough, existing critical data on the subject have not come from those sources in which special effort has been made to obtain the desired results. They have been derived entirely in connection with microscopical petography, incidentally, as it were. There are strong logical reasons, as well as practical reasons, for believing that in the case of the igneous rocks the question can only be definitely disposed of through means of the microscope.

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## GENESIS OF CERTAIN CHERTS.

BY CHARLES R. KEYES.

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As regards origin, the cherts which occur so abundantly throughout the limestones of the lower carboniferous of the Mississippi valley have been the subject of much speculation. The same problem has received attention from every quarter of the globe. While the explanations offered differ very much from one another they in general agree in that they are regarded as formed contemporaneously with the geological formations in which they occur. The writings of Prestwich, Irving, Van Hise, Hull, Benard, Hinde, Hardman, Hovey, and many others corroborate this statement.

That the cherts may have been secondary features, formed long after the rocks containing them were laid down and consolidated, does not seem to have occurred to any of the writers mentioned. That some of the Carboniferous cherts of Iowa and Missouri have been formed in the rocks long after the latter were formed there is small doubt, as subsequent statements will conclusively show. How extensive this secondary mode of chert formation is, is not as yet definitely known. It is believed that the process is of wide application, if not universal, so far at least as concerns the Carboniferous cherts of the two states mentioned.

In southwestern Missouri, in the mineral belt, the cherts constitute extensive layers interbedded with limestones. In many cases the proportion of chert greatly exceeds that of the limestone. So marked is this preponderance of silicious beds that the formations or terranes are called "cherts" in place of "limestones."

Were one to study the cherts of southwest Missouri alone, he might long look for evidence for any other explanation of genesis than that of a formation contemporaneous with the geological terrane. We get an important clue, arguing for non-contemporaneity of formation of the chert and inclosing limestone, in a consideration of the lower carboniferous terranes of southeastern Iowa and northeastern Missouri, when the chert constitutes a comparatively small part of the whole terrane.

Careful comparisons of the fossils from these cherts and those of the surrounding limestones show that the forms to a great extent are identical. Moreover, numerous shells and crinoids are found partly imbedded in the chert and partly in the limestone, and fossils likewise half chert, half limestone, with a sharp line of separation, indicating clearly that the silicious impregnation was acquired long after the original deposition of the beds, and was not due to a greater silicity of the waters in which the calcareous deposits were made, as has been held by many prominent writers. This is in accordance with observations made elsewhere in the Burlington limestone.

Considering in this light the cherts of the Missouri mineral belt in the southwestern part of the state similar conditions appear to have prevailed. The calcium carbonate of the fossils is found entirely replaced, one end only replaced, or only a small part replaced, by chert. A similar replacement also takes place in which iron sulphide is substituted for the original material of the fossils. Likewise zinc sulphide, the principal ore of the district, is found composing fossils as perfectly as in the original, every structure being perfectly preserved.

From these facts, and many others, no other conclusion can be reached but that the cherts were formed long after the terranes were laid down; that the cherts were formed under the same conditions as the ores of the region, and that, like the ores, the cherts were formed at a comparatively recent date; that, as in the case of the ores, the cherts were formed by the displacement of the original limestone molecule by molecule.

The formation of the ores of the region is going on rapidly at the present time. The last uprising of the Ozark dome is not believed to be yet finished. The formation of ore and chert is manifestly very recent, geologically speaking. It is not impossible, but not probable, that the whole transformation may have taken place within the memory of man.

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## COMPARATIVE VALUES OF DIFFERENT METHODS OF GEOLOGIC CORRELATION IN THE MISSISSIPPI BASIN.

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BY CHARLES R. KEYES.

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(Abstract.)

The need of a number of independent criteria in the broader work of geologic correlation has never been more apparent than at the present time. Yet for necessary