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PROVINCIAL UNITY OF CONTINENTAL INTERIOR COAL-FIELDS.

CHARLES KEYES.

With their extreme simplicity of geological structure it seems almost incredible that the coal-fields of the Continental Interior should remain so long without even approximate correlation of their several parts. That the Arkansas district, the Western Interior area, the Eastern Interior field and the Michigan basin are essential parts of a single stratigraphic province there is now little reason to doubt. Recent regional planation manifestly separates a once continuous plate by removing the coal measures over the crests of broad gentle folds and preserving from the effects of erosion the deposits lying in the troughs.

The physiographic conditions existing when the coal measures were laid down are not so very hard to restore in fancy. The great plane of unconformity which characterizes the floor over such a large part of the region is clearly a Mid Carbonic peneplain of remarkable extent and smoothness. It represents perhaps the largest and most perfect peneplain known. It extends from central Arkansas north and northeast far upon the crystalline Canadian shield beyond the Great Lakes. Without interruption and with gradual encroachment the marine coal-marshes doubtless crept up towards the pole far into Canada. Late Carbonic, Comanchan, Jurassic and Triassic warpings of the earth's crust were wide spread over the coal region. In southern Minnesota the flexing devolved into a lofty mountain range that rivaled the Appalachians of today. Other folds broader but perhaps not so high developed elsewhere through the Continental Interior. Between the base-leveling of Cretacic and Tertiary times all topographic eminences were completely and smoothly worn down. The once vast and continuous coal-field thus became broken up into a number of separate basins possessing much the character that they have at the present day. Inattention to these fundamental stratigraphic facts is no doubt the main cause of the failure to correlate the several State sections.

Half to three-quarters of a century ago, when the coal measures of the region first came in for systematic consideration, it was widely thought that careful comparisons of the contained

fossils would furnish an exact vertical section and a ready means of paralleling coal-seams and guide-horizons in localities widely separated from one another. As time went on this proved notably unsatisfactory and inconclusive. As a practical method of correlation the scheme was long since abandoned. In view of the peculiarities of original sedimentation and the rapid alternation of lithologic and consequently physical conditions it now appears to be extremely doubtful whether the organic remains of these formations will ever prove to be effectual correlative features. This is particularly true of Kansas where the method experienced the severest test.

With the complete break-down of the fossils as correlative criteria in Kansas, Missouri and Iowa and in fact throughout the Western Interior coal-field, correlation was largely conducted by direct tracing of strata from point to point, until there resulted one of the most complete and precise rock-classifications known. In the meanwhile similar detailed field-work in the Eastern Interior coal-basin lagged. Through fortunate preservation of a narrow belt of coal measures by drop-faulting* a part of the western section was traced across the supposed barren area along the line of the Mississippi river, that was so long regarded as completely isolating the two great coal-fields.

The wide lithologic homogeneity and terranal continuity of many of the beds constituting the coal measures permits single units to be traced over surprisingly long distances. That the Illinois and Missouri sections have never been matched up, as it were, or that the Arkansas and Kansas-Missouri strata have not been closely paralleled is doubtless due largely to the circumstances that public systematic investigations seldom transgress state boundaries. The workers in one part of the province are wholly without intimate knowledge of what has been done elsewhere. The great force of this shortcoming led, not so very long ago, to a critical personal inspection of the conditions existing in states contiguous to those in which principal investigations had been previously carried on. Among the facts discovered were that the southern coal measures were mainly beneath the base of the Missouri and Iowa measures, and that there was actually great similarity between the general sections of the Eastern Interior and Western Interior Coal-fields. A host of once incongruous features was thus readily explained.

*Proc. Iowa Acad. Sci., Vol. XXIV, p. 53, 1917.

The detailed comparison of the Eastern Interior and Western Interior sections is rendered easy for the reason that it was found that instead of being separated by a wide belt of older rocks the two are actually continuous. This is made evident by the profound Cap-au-Grès displacement which crosses the Mississippi river near the mouth of the Missouri river. This fault having a throw of 1,000 feet drops the coal measures down so that there is now an unbroken belt of them extending from Indiana to Kansas. In this trough also the basal limestones of the Missourian, or Upper Coal, series are brought nearly 100 miles closer together than had been previously suspected.

The problem of comparing the Eastern Interior and Western Interior sections thus consists merely of matching up, after some little special investigation at critical points, the sequence of beds on the two limbs of a broad arch the crest of which is removed through erosion. In the west, in Missouri and Kansas, the details of the rock succession are more clearly discerned on account of the country there being free from glacial debris. The wealth of detail there deciphered is at once the joy of geologists who work in the region and the despair of outsiders who are unacquainted with such refinements of stratigraphical conditions. It is the most completely differentiated section of the coal measures in the United States.

On the other hand the coal measures of Illinois are the longest known and least understood stratigraphically of any coal deposits on the American continent. Notwithstanding the circumstance that one of the very first discoveries of mineral coal in America was made in 1680 near the present city of Peoria, the Illinois section remains today almost as completely undifferentiated according to modern standards as it was three centuries ago.

With the exception of an early attempt, when the Permian controversy was at its height in this country, to show by the contained fossils that certain beds near La Salle were to be compared with the Kansas Permian section (*i. e.*, Permo-carboniferous, or Missourian) all efforts appear to have been towards establishing correlative relationships with eastern sections. This tendency seems all the more pronounced since a concerted movement was inaugurated to take the Pennsylvanian section out of the provincial class and make it the standard succession for the entire continent. In so doing important affinities are wholly

lost sight of. Paleogeographical relations are forgotten. Paleontologic evidences are not analyzed. Lithologic similarities are overlooked. Similarity of lithologic sequence is passed over as if of inconsequential character. Fundamental canons of correlation are completely ignored.

Another important feature directly bearing upon the consanguinity of the Illinois or Eastern Interior with the Western Interior field is the recent determination of the eastward extension of the Bethany limestone or basal member of the Upper coal measures far beyond its previously recorded limits. This discovery in the trough of the great Cap-au-Grès fault in north-central Missouri places the boundary of that member more than 50 miles in advance of any hitherto recognized eastern outcrop, and within only 50 miles of the Illinois line.

There are several advantages in selecting for the Illinois area the coal measures section constructed by A. H. Worthen. This section is made up in the same way as was the eastern Kansas section. It was erected under the guidance of F. B. Meek, who was at the time a co-laborer of Worthen and than whom no worker was more familiar with the Kansas sequence. Worthen's section has a further advantage over later ones in that it goes into sufficient detail and was made by one who had gone over the whole field.

Adjudicating the paleogeographical affinities of the Illinois coal measures according to the standard of the Kansas, Missouri and Iowa sections there appears to be in the several successions a wonderfully close correspondence in general features. This parallelism is well indicated in the subjoined table:

TABLE OF COAL MEASURES TERRANES

SERIES	TERRANES	KANS.		MO.		IOWA		ILLINOIS	
				Ab.	Ab.	Ab.	Ab.		Ab.
Oklahoman		800		Ab.		Ab.			Ab.
	Atchison Shales	800		300		300		— Shales	235
	Forbes Limestone	25		35		25		Effingham Li.	8
	Platte Shales	200		125		150		— Shales	200
	Plattsmouth Li.	75		50		30		Martinville Li.	30
	Lawrence Shales	300		225		100		— Shales	100
	Stanton Li.	125		30		20		Livingston Li.	20
	Parkville Shales	100		100		100		— Shales	75
	Iola Limestones	30		40		Ab.		Li. wanting	Ab.
	Thayer Shales	200		100		75		— Shales	75
Des Moines	Bethany Li.	100		75		50		Shoal Limestone	7
	Marais des C. Sh.	525		300		250		— Shales	350
	Henrietta Li.	100		175		100		Mason Li.	100
Arkansan	Cherokee Shales	400		225		450		— Shales	200
		Ab.		Ab.		Ab.			Ab.

A point of special industrial interest is the fact that more than 95 per cent of the available coal tonnage in the Eastern Interior field is confined to horizons in the Des Moines Series. This is another genetic factor linking it with the Western Interior field where 98 per cent of the coal is also found to be restricted to the same series.