# UNUSUAL SPECIMENS

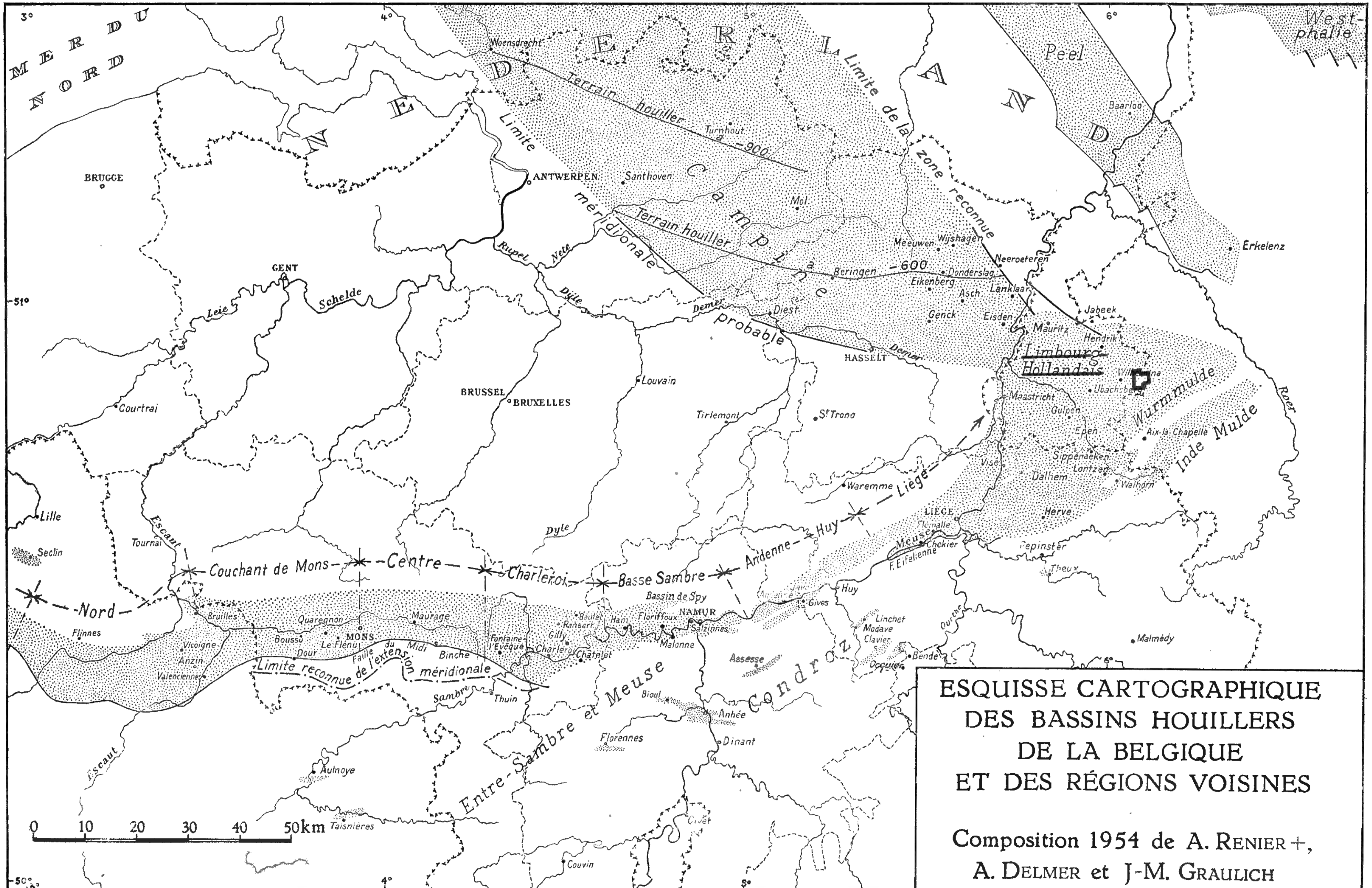
OF

# VERTICAL CONE-IN-CONE IN DUTCH COAL

BY

W. F. M. KIMPE

(1 Plate.)




**ESQUISSE CARTOGRAPHIQUE DES BASSINS HOUILLERS DE LA BELGIQUE ET DES RÉGIONS VOISINES**

**Composition 1954 de A. Renier +, A. Delmer et J-M. Graulich**

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# VERTICAL CONE-IN-CONE IN DUTCH COAL

ABSTRACT. — An exeptional type of cone-in-cone is described from a layer of pseudo-cannel coal of seam Groot Mühlenbach, Domanial mine, the Netherlands. Nest of large, half circular, obtuse coal cones, having the axis perpendicular to the stratification, usually stand in inverted, seldom in normal position. The polished and slightly longitudinally slickensided cone surfaces are all faced in one direction.

The partially developed conical surfaces of this type of secondary cone-in-cone represent shear planes, originated as a product of some local vertical stress connected with faulting, having been active under specific, favourable conditions on a suitable sediment.

## INTRODUCTION.

Recently a group of rare conical structures, for the greater part having their base upward and apex down with the cone axis normal to the bedding, was discovered in a layer of pseudo-cannel coal from seam Groot Mühlenbach in the Domanial mine, the Netherlands. These structures, which are referred to as cone-in-cone, resemble in general appearance the classic type of calcareous bedding plane cone-in-cone, represented by nests of abundant concentric circular cones of fibrous calcite, mostly standing in inverted position. In PETTIJOHN's book (1949) a synopsis is given concerning distribution, external and internal features and supposed origin of calcareous cone-in-cone (see also TARR, 1932 an CORRENS, 1939). It is stressed that the conical structures in question are entirely different in shape and disposition from the relatively widespread conical structures in coal with horizontal cone axis such as have been described by DEENEN (1942) from Dutch coals as « fishbone » structures which characterize certain types of cleat fractures and longitudinally striated conical fractures (« cone-in-cone »), both with horizontal cone axes parallel to the bedding (see also DUPARQUE, 1933, cone-in-cone; STAINIER, 1931, structure flabellée; KUKUK, 1938, Pyramidenstruktur).

Cone-in-cone having the cone axis perpendicular to the bedding plane apparently is very exceptional in coal and heretofore has not been mentioned from Dutch coals. The only records found in the literature have been made by Garwood (1892), Tarr (1932) and Price (1933). Some cases of vertical « structures flabellées » have been mentioned by Stainier (1931).

## DESCRIPTION.

The cones occur near the top of seam Groot Mühlenbach in a 16 cm thick layer of pseudo-cannel coal, separated from the underlying 51 cm thick coal by an 8 cm thick stone band of bituminous shale changing downwards into ordinary shale. The roof sediment is composed of sandy shale. The occurrence of the cones has been observed covering an area of about a square meter, some 15 meters West from a North-South striking, eastward dipping normal fault, the « Westelijke storing ». The pseudo-cannel coal at this locality shows a stressed appearance. Various cleat systems of which especially an approximately North-South striking set is characterized by large « eyed » structures, and horizontally striated fractures showing « fishbone » structures are very prominent.

The individual and multiple, broad and obtuse cones have their axis at right angles to the bedding and stand in alternating normal (fig. 1) and inverted (fig. 2) position, the cones of the latter position being the largest and most plentiful. Complete circular cones are absent. Only a half to two thirds of a complete cone is developed. The polished and finely slickensided cone surfaces, which usually are slightly concave in the middle but rather become convex towards the base, invariably are faced to the South. They are well delineated from the adjacent coal from which they loose without difficulty. The base angles of the cones vary between 40° and 45°, the apical angles thus change from 100° tot 90°. The diameter of the cone bases therefore attains approximately twice the height of the cones. The dimensions of the largest inverted cones amount to respectively about 32 cm and 16 cm. These cones, which have their apex resting on the stone band and their base reaching up to the sandy roof sediment, from which they are released readily, clearly demonstrate that their height is controlled by the thickness of the layer of pseudo-cannel coal. The small cones standing in normal position, up to about 5 cm in height, exclusively are developed in the lower part of the pseudo-cannel coal immediately above the stone band from which their base cannot be separated easily. Cross-sections of individual cones show that only a few, more or less concentric cones have been developed. Outer cones often partially envelop the inner cones in a tilelike arrangement, such as to suggest that during their formation some rotation was involved. A rapid thinning out of the outer cones, giving rise to a broad distribution of sharp deep furrows which falsely resemble a coarse longitudinal striation, produces crenated outlines in cross-section. The base and counterpart of the inverted cones show a remarkable pattern of more or less concentrically and spiraly arranged lines and minute rims. Corresponding to the intersections of the successive cone surfaces, they apparently represent extremely thin films of later mineral fillings (calcite, kaolin minerals) deposited between the conic scales. In particular near the base it is seen that the cones readily break off according to a system of cylindrical planes which tend to be parallel to the cone axis or slightly incline in reverse to the main cone surfaces.

## ORIGIN.

Various theories and conceptions have been advanced to account for the origin of cone-in-cone in general. With the omission of now abandoned previous discussions, only the most important recent theories by Tarr (1932) and Shaub (1937) will be considered in particular reference to the present cone-in-cone structures in coal.

Tarr's pressure-solution theory (1932), elaborated for a substitute of his original pressure theory (1922), involves pressure derived entirely from the weight of overlying sediments which, acting differentially along conical shear planes, concomittantly causes solution accompanied by relative movement of cone and cup. Though, in regard to the origin of the common calcareous cone-in-cone layers « ...most geologists agree that pressure is involved... » and « ...solution is prone to take place... » (Pettijohn, 1949), the concomittant solvent action was stated to be lacking in insoluble materials such as coal and Tarr (1932) then appealed only to pressure caused by loading. Similarly Price (1933) reached at the conclusion that the conical structures in bituminous coal of West Virginia « represent planes of maximum shear from vertical stresses and that no solution is necessary to explain their origin ».

Shaub (1937), who raised many objections to an epigenetic origin as postulated by the pressure-solution theory, argues a primary origin of most cone-in-cone structures « ...as a result of contraction, settling or volume shrinkage during dewatering of highly saturated, porous, fine-grained sediments of any kind (...including certain kinds of coal...) deposited under a loosely packed condition ». He distinguished two types of primary cone-in-cone, one type originated as superficial conical depressions « in which the cups antedate the cones » and a second type, developed under a light cover of later sediments, « in which the cups and cones are developed simultaneously ».

Without elaborately criticizing Shaub's views in regard to a primary genesis of the most common calcareous cone-in-cone, Brown (1954) recently rightly disputed their validity in discussing the emplacement of cone-in-cone calcite separating the counterparts of the imprint of a fossil fish, only pointing out that « ...a striking analogy as far as the end products are concerned... » not necessarily holds that « ...the processes leading to those ends are identical ».

Nor Tarr's pressure-solution theory, nor Shaub's conceptions in favour of a primary origin of most cone-in-cone offers an adequate explanation for the present type of cone-in-cone in coal.

It is beyond all doubt that the general character of the external as well as of the internal features of the conical structures in coal, standing in alternating normal and inverted position, rather suggest a secondary than a primary origin. According to Shaub (1937) secondary cone-in-cone very exceptionally « ...originates in consolidated materials as the result of static pressure accompanied by a lateral release of pressure, which, except under very special conditions, can occur in one direction only, as along shear planes... ». In consequence only a third or a half of a complete cone can develop which ordinarily is characterized by slickensides, if material and conditions permit. The conical structures in coal here described show a striking resemblance to Shaub's type of exceptional secondary cone-in-cone. They have, however, little in common with the « ...highly compressed, narrow, elongate cones with very small apical angles,... grooved longitudinally by striæ... », as described by Bartrum (1941) from some New Zealand coals (see also Fyfe and Wellman, 1937). These alternating cones with the axes approximately coïnciding with the stratification are classified by Bartrum (1941) erroneously — in the writer's opinion — amongst Shaub's third type of rare secondary cone-in-cone. They are explained by lateral stress and correspond (Bartrum, 1941, fig. 1) to the conical fractures as described and reproduced by Deenen (1942, photographs 51 to 56) from many Dutch coals.

From this brief summary it will be clear that the strongly differentiated types of cone-in-cone, occurring in different kinds of sediments, suggest a multiple rather than a uniform mode of origin.

As to the origin of the here considered vertical conical structures, which after their appearance fall rather well in Shaub's third class of secondary cone-in-cone, it is supposed that the omnipresent static pressure, caused by loading, has not been an important active factor as thought by Shaub (1937). The scarcity and local distribution of the present conical structures, covering a relatively small area in a layer of pseudo-cannel coal only, seem to imply a specifically limited genesis which largely is controlled by a co-operating action of a number of prevailing favourable conditions, such as the suitability of the consolidated sediment to react upon specific external active forces. It is believed that the conical surfaces represent shear planes resulted from a local, rather upward than downward directed vertical stress, which presumably was connected with the origin of the neighbouring fault, being active under conditions of unilateral pressure relief, probably accompanied by some horizontal rotation.

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PLATE

## EXPLANATION OF PLATE.

FIG. 1. — Side view of a cone-in-cone specimen of pseudo-cannel coal, standing in inverted position. The base of the cone, representing the stratification, is detached from the roof rock. Magn. ± 2/3. Seam Groot Mühlenbach, Domanial mine.

FIG. 2. — Side view of a cone-in-cone specimen of pseudo-cannel coal, standing in normal position with its base resting on a shaley stone band. Magn. ± 2/3. Same locality.

FIGURE 1

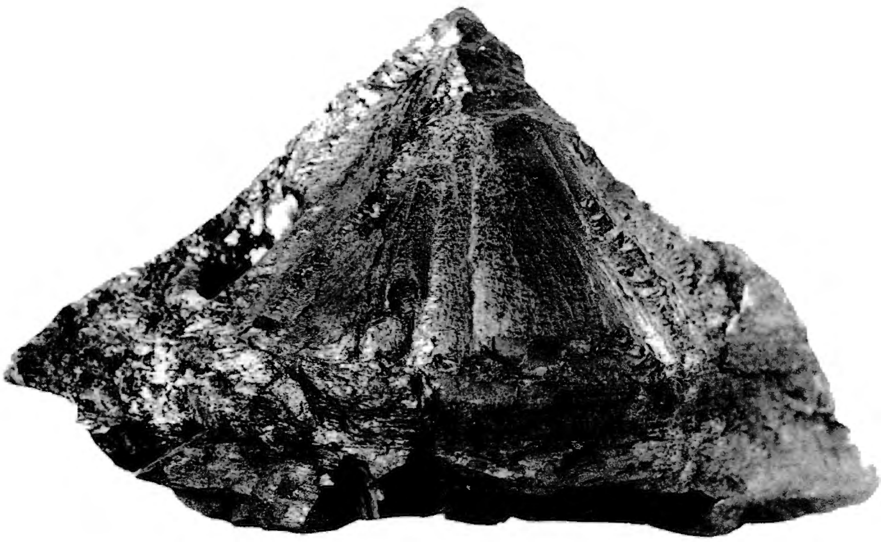

FIGURE 2

W. F. M. KIMPE. — Unusual Specimens of Vertical Cone-in-cone in Dutch Coal.

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