Hydrogeochemical Environment in the Lublin Coal Basin in East-Central Poland

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ABSTRACT

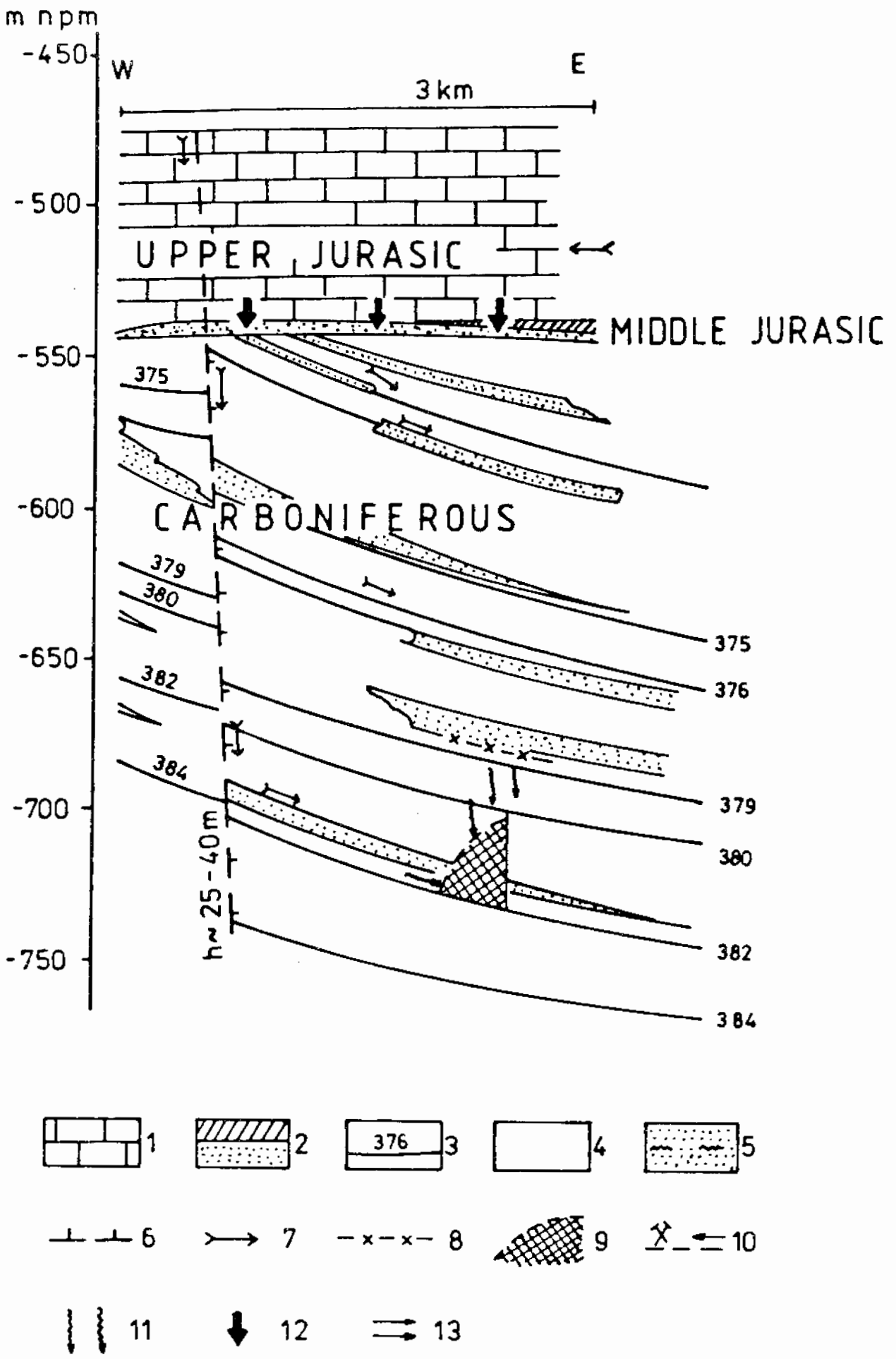
This paper reports on the hydrochemical environment of coal beds series in the Lublin Coal Basin. Present geochemical conditions of coal beds have been influenced by many geological and hydrogeological effects. The results of the geochemical investigations of mine ground waters including rare elements are presented.

INTRODUCTION

Present geochemical potential of Lublin Coal Basin coal beds series has been created as a result of mineral and phytogenic processes in the hypergenic environment of Upper Carboniferous as well as postsedimentional diagenesis and epigenesis within the framework of multiple tectonic activity, metamorphic interaction of thermal flux, mineralizational activity of solutions in the loosen zones as well as frequent exchange of pore waters, associated with hydrogeological evolution cycles of this region[1,2]. Geochemical potential formed in those processes and the occurrence form of respective elements will decide about the behaviour character of body deposit components during the mining processes.

HYDGOGEOCHEMICAL FEATURES

The artesian basin in whose range the Lublin Coal Basin is located underwent several cycles of hydrogeological evolution. Present hydrogeochemical waters regime of Carboniferous formations is formed by the palaeo-infiltration waters, which displaced primordial Palaeozoic brines. It includes Mesozoic cover with the top of Carboniferous up to the depth of 900 m approximately and is intensified by drainage associated with coal exploitation. The scheme of hydrogeochemical regime of coal beds series is shown in Figure 1.



Explanation:

Upper Jurassic: 1 - Bioclastic, oolitic and pelitic limestones; Middle Jurassic: 2 - dolomites and sandstones, the Lublin beds (Westphalian A-B); 3 - coal seam number, 4 - claystones, 5 - sandstones and siltstones, 6 - faults in the Carboniferous, 7 - presumed infiltration direction in the rock massif undisturbed by mining (drainage), 8 - presumed extent of the fractured zone over the roof caving, 9 - boundary between lateral tension and compression, roof caving zone, 10 - exploited seam and exploitation direction, 11 - water seepage into producing long-wall and roof-caving zone, 12 - sedimentary transgressive contact zone of the Jurassic and Carboniferous sediments, 13 - hydraulic contact of tectonic type.

Figure 1: Geological cross-section illustrating the hydraulic connection of the Jurassic and Carboniferous layers in tha Central Part of Lublin Coal Basin, after Rudzinska-Zapasnik (1989), changed by the authors.

Water leakages and refluxes in the exploitation level undisturbed by mining (level of 920 m) represent Na-Cl and Cl-Na chemical type of pH=7.6-8.6 and total mineralization of average value 4.5 g/dm^3. rNa and rCl indices fall between 0.93 and 0.99 which indicates the zone of difficult water exchange and a weak contact with atmospheric waters[3].

Within Carboniferous formations the reduction conditions exist. In the gaseous composition nitrogen, carbon dioxide and methane prevail. Waters flowing out from the fall of roof zone represent exclusively the HCO_3-Cl-Na chemical type and average mineralization of 3.5 g/dm^3 characteristic for the Carboniferous top and the bottom of Mesozoic overburden.

The mixing of waters and changes of redox potential connected with intensive ventilation of excavations cause dynamic changes of hydrochemical field as a result of mineral phases dissolution (molecular diffusion and convection), oxidation as well as ion exchange within sorptive complex of clay minerals. The sorptive complex of colliery rocks of exploited coal bed consists of poor ordered oolit 1Md, Na-smectite as well as mixes-layered illite/smectite and chlorite/smectite. This complex is saturated by sodium. The inflow of low mineralized Ca-bicarbonate and carbonate waters causes the exchange of Ca-Na within sorptive complex and formation of rarely encountered basic sodic waters.

From the view point of elements cycle and their migration to formation water in the coal beds and colliery rocks of Lublin Coal Basin it seems that sulphides (pyrite generally), carbonates (siderite, calcite, dolomite) and chlorides (halite) as well as sulphates (kieserite, jarosite, barite) are the carriers of active migrants. The examinations of rare elements at the mine waters performed over a span of 1978-1984 years (initial period of first working) confirm this. They demonstrate the relative increase of element contents related genetically with above mentioned mineral groups. It is especially distinct for lead, whose contents increase from 1.5 ppm (average values) to 30 ppm at about 15 ppm in the colliery rock and 600 ppm in pyrite. The occurrence shape of pyrite (fine crystalline, incrusted, framboidal) permits to assume facility of weathering and concurrent liberation of lead into waters.

The observed zinc contents increase can be explained in a similar way. The concentration decrease of other elements, e.g. Cu from 10 ppm to 3 ppm and Cr from 20 ppm to 0.5 ppm at their relatively high contents in the rocks (100 ppm and 150 ppm respectively) indicates their high geochemical inertia and simultaneously the lack of their presence in the exchangeable complex of clay minerals.

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