МІНЕРАЛОГІЧНИЙ ЗБІРНИК
2008. № 58. Вип. 1–2. С. 80–87

MINERALOGICAL COLLECTION
2008. N 58 (1–2). P. 80–87

UDC 553.251:552.323.6

APPLICATION OF SECONDARY KIMBERLITE MINERALS FOR DEFINITION OF DIATREMES' EROSIVE CUT

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Results of complex research of secondary kimberlite minerals in connection with possibility of their application for specifying the size of an erosive cut of kimberlite pipes are given, which is recommended to use in combination with geologic-structural investigations concerning this question. The small erosive cut of diatremes (pipes Aykhal, Yubileynaya, Sytykanskaya and others in Daldyn-Alakit region of the Siberian platform) is emphasized by availability of layered kimberlite tuffs of sedimentary-volcanogenic origin in upper parts of the finds. The presence of thick weathering profiles at the top levels of volcanic pipes can also point to weak erosive cut of kimberlites. Practically complete disappearance of amethyst-like quartz druses in such pipes at the depth of several tens of meters from the surface can also be interpreted as the proof of their development in the tops of poorly eroded kimberlite bodies. In that case frequent finds of quartz and chalcedony druses and other new formations in kimberlites of the pipes' upper levels as well can also be considered indirect evidence of weak erosive character of the pipes, which should be taken into account when forecasting diamond placers in this region.

Key words: kimberlite pipe, secondary kimberlite minerals, erosive cut, diamonds, Siberian platform.

For estimation of the degree of placer diamondiferousness of the regions it is very important to know the size of the erosive cut of primary diamond deposits, which have served as the basic suppliers of diamonds in sedimentation basins, which subsequently have led to concentration of useful component. The size of the erosive cut of kimberlite pipes is one of the main factors of productive horizons' formation, as it defines the amount of kimberlite minerals transferred in haloes of their dispersion, on which prospecting of buried primary deposits of diamonds is performed. Therefore, correct estimation of both its total size and by separate intervals of time has great significance during planning of prospecting works. Within the limits of the same platform in various regions there can be different scales of kimberlite pipes' denudation and so the difference in features of placer diamondiferousness. Various diamondiferous regions of the Siberian platform can serve as a good example in this respect. Thus, for example, the erosive cut of kimberlite pipe Mir is defined by many researchers in 350–400 m, which caused the formation of numerous Upper Paleozoic, Mesozoic and modern placers of diamonds in Malo-Botuobinsky diamondiferous region. Unlike this, we consider that the erosive cut of kimberlite pipes of more northern on the same platform Daldyn-Alakit region constitutes the first tens meters and this defines insignificant placer diamondiferousness of this territory on the whole. The analysis of material composition of kimberlites according to investigation data of deep horizons and operation data of upper parts of pipes Mir, Inter-

national, Aykhal, Udachnaya, Sytykanskaya, Yubileynaya, Botuobinskaya, Nyurbinskaya, Karpinskaya, Lomonosov, Finsch, Orapa, etc. allows to plan original vertical zonality which occurs in alteration of composition and structure of kimberlites. Not going into detail of this question, we shall pay attention only to the character of alteration of secondary mineralization of kimberlites of some pipes with depth. The attention of researchers has long been attracted by crusts of weathering developed on some pipes. Especially thick zones greatly weathered rocks are revealed on some kimberlite pipes of African, Siberian and East-European platforms where with depth strongly altered rocks are replaced by desintegration zone, which then transforms into dense kimberlite. Besides hypergene zonality the degree of kimberlite treatment by secondary processes under the action of postmagmatic solutions changes with depth: degree of rock serpentinization and chloritization usually decreases and orientation of some other processes changes. It is natural that at unequal denudation cut of kimberlites different zones of secondary mineralization will expose to the surface. Hence, it is often possible to judge about the size of the erosive cut of kimberlite bodies by character of secondary minerals. At the present stage of the level of knowledge about vertical zonality on secondary minerals, when defining the size of pipes' denudation, it is obviously possible to recommend the following criteria: a) availability or absence of unique sedimentary-volcanogenic rocks in upper horizons of kimberlite pipes; b) degree of development and character of hydrothermal mineralization; c) availability of thick well chemically treated crusts of weathering in upper parts of the pipes. Application of sedimentary-volcanogenic rocks, which occur in the uppermost part of non-eroded pipes, became possible in connection with their research on pipes Mwadui, Orapa etc. Thus, in the region of pipe Mwadui, emissions of volcanic tuff in the form of a ring bank were kept. Comparing investigation results of kimberlite pipes Mwadui and Orapa, and also geological structure of these pipes with composition and structure of upper horizons of some pipes of the Siberian platform, it became possible to reveal much in common between them. Upper horizons of pipes Yubileynaya, Aykhal, Botuobinskaya, etc, have the closest structure in comparison with African kimberlite pipes. Sedimentary-volcanogenic tuffs of non-eroded diatremes are presented basically by serpentine and carbonates, therefore the results of their detailed complex research can be employed during diagnostics of redeposited (derived) rocks of upper horizons of pipes and the decision of a question on the size of the erosive cut.

When defining the erosive cut of kimberlite pipes it is possible to be based on the fact that as a result of investigation and operation of upper horizons of kimberlite pipes Udachnaya, Mir, Yubileynaya, Aykhal, Sytykanskaya, Botuobinskaya, Nyurbinskaya and others a lot of cavities were discovered, infilled by hydrothermal mineralization – calcite, quartz, sulphide and other secondary minerals. Quartz and calcite quite often form large, beautiful druses. Especially big cluster of sufficiently large druses of violet amethyst-like quartz has been revealed during processing of upper horizons of pipe Aykhal. We have studied in complex numerous druses of various quartz types from some sites of upper horizons of pipe Udachnaya where there is abundance of them in the western body. In kimberlites of lower levels of the same pipes cavities occur less often, and quartz mineralization disappears in general. It is possible to assume that druses of quartz in upper horizons of pipes were formed during hypergenesis due to mobilization and deposition of SiO_2. At such treatment hydrothermal mineralization of quartz and other minerals could not be used as the criterion for definition of size of erosive cut for the reason that it could be formed in upper horizons of already eroded pipes, as the stage of hypergenesis can be

considerably separated from the stage of pipes' formation by time. However, high-temperature character of quartz, including its weak-violet difference, testifies against this. Our investigations reveal that crystallization temperature of quartz of early generation from kimberlites reaches 350–400 °C. It excludes possibility of its generation during weathering and unambiguously testifies that this quartz, as well as some other secondary minerals forming close paragenesis with it, crystallized from high-temperature hydrothermal solutions which could arise only at early stages of the postmagmatic process.

The resulted materials on approximate definition of the erosive cut of kimberlite pipes concerning secondary kimberlite minerals are compared by us with geological data on the same question. The analysis of geological development history of the considered territory in Late Palaeozoic allowed establish various size of the erosive cut of its different areas. Thus, rocks of Upper Cambrian Mirny suite are developed in the south of the region within the central part limits of Angara–Vilyuy sagging under Mesozoic deposits. Further north, along the arch part of Botuobinsky uplift and farther than Syugdzherskian saddle under Upper Paleozoic deposits formations of Kholomolokskian suite of Upper Cambrian (on bottoms of paleowaterway valleys) and Balyktakhskian suite of Lower Ordovician are established. Within the limits of eastern slope of these large positive structures, in the basin of small rivers Ualaah–Jurjue and Balyktakh in the south, and up to river Morkoka in the north, deposits of Middle and Upper Ordovician, and by sites of Lower Silurian were kept from washout, frequently in lowered tectonic blocks. The specified rocks are noted on western slope of Syugdzherskian saddle, as well, in the basin of r. Morkoka. In north-western part of the region, in Alakit-Markhinsky kimberlite field these rocks are developed everywhere under Upper Palaeozoic deposits. Having the qualitative characteristic of a degree of rocks' erosive character of Lower Palaeozoic of the region prior to the beginning of Late Palaeozoic sedimentation, we made an attempt to estimate it in a quantitative sense. Data on definition of the size of the erosive cut of pipe Mir, which is located within the limits of Malo-Botuobinsky diamondiferous region (in the south of the region) have served as the basis for this purpose. Estimations of the erosive cut Middle Palaeozoic kimberlite pipes of this region, as it was already mentioned above, performed by different researchers and various methods, frequently considerably differ. Thus, concerning kimberlite pipe Mir marginal estimates vary from practically full absence of the cut [6] up to 500–600 m [7]. Making the size of Post-Middle Palaeozoic erosive cut of kimberlite bodies of Malo-Botuobinsky region more precise one should note that since the moment of kimberlite magma introduction till present time there were three large denudation cycles: Pre-Late Palaeozoic, Early Mesozoic (Pre-Ertskian) and Cainozoic. The analysis of geological development history of the territory during these cycles, and also direct geological data testify that the strongest denudation of rocks occurred in Pre-Late Palaeozoic time, since, as it was already mentioned, the Permian depositions, developed mainly in northwestern part of the region, lie with washout on different horizons of rocks of Kholomolokhskian suite of Upper Cambrian [14]. Besides, kimberlites of pipe Mir, as it was discovered, host xenoliths of limestones with fauna of Meikskian suite of Lower Silurian, absent at present in the section of depositions near this pipe. In the modern cut pipe Mir is exposed to day time surface. Country rocks are constituted by terrigenous-carbonate depositions of Kholomolokhskian suite of Upper Cambrian and only its higher south-eastern part which has kept from washout contacts with marlaceous-dolomitic formations of basal horizon of the Lower pack of Balyktakhskian suite of Lower Ordovician. Younger rocks of Lower and Middle Palaeozoic in the region have

not preserved by present time. This emphasizes, that in Pre-Late Palaeozoic time depositions of Lower Silurian, Upper and Middle Ordovician, and substantially of Lower Ordovician were washed away. Small in area fields of their development preserved from the latter in the region of pipe Mir. They are widely spread only in extreme northeast of the region, in 50 km from pipe Mir, within the limits of south-western suburb of Middle Palaeozoic Ygyatinskaya depression. Here is a section of Palaeozoic rocks, which are absent in the region of pipe Mir, beginning since Lower Ordovician up to Lower Silurian represented in larger scope on the following suites: Meikskian of Upper Silurian (160–180 m), Oysutskian of Upper Ordovician (40 m), Khariyalakhskian of Middle Ordovician (50–85 m), Stanskian of Middle Ordovician (35–60 m), Krivolutskian of Middle Ordovician (40–90 m), Balyktakhcкая of Lower Ordovician. The minimal thickness of these rocks is equal to 345 m, and maximal is 550 m. Middle Paleozoic kimberlite bodies of the region are in the arch part of Botuobinsky consedimentational paleouplift (north-eastern end of Nepskian-Botuobinskaya anteclise) which from the end Early Ordovician again began to occur intensively as a positive structure. Therefore the thickness of generated here rocks of Ordovician and Silurian tends to its reduction towards an axial line of the uplifting. However, it is difficult to determine the size of such reduction therefore it will be more correct to accept the minimal thickness of washed out rocks equal to 345 m in calculations.

Establishment of Pre-Late Palaeozoic section of the specified pipe in figures is possible only after defining the size of its Pre-Ertskian and Cainozoic denudation. According to direct geological data Cainozoic cut of kimberlite pipe Mir is insignificant and constitutes only about 5 m. Washout of kimberlite bodies of the region in Pre-Ertskian time is determined by value equal to the distance along vertical between the foot of depositions of Upper Palaeozoic and Mesozoic, overlapping kimberlites accordingly before the beginning and after the end of Pre-Ertskian denudation. Of course, this value can be restored authentically only in the case if mentioned above depositions preserved from washout in immediate proximity of kimberlite bodies. Such favourable position is noted close to pipe Mir. Thus, the nearest field of Lower Jurassic formations' development is only 200 m south-east of this pipe. The contact of specified formations with rocks of Lower Palaeozoic is established here at the level of 325 m mark. Deposits of Upper Palaeozoic are mapped one kilometre north-west of pipe Mir in the form of preserved from washout small outliers [4]. Here position of the foot of these depositions is marked at 365 m level. It allows to state [4, 14] that washout of kimberlite pipe Mir in Pre-Ertskian time is defined in 40 m. For other known in the region kimberlite pipes their size denudation in Pre-Late Palaeozoic, Pre-Ertskian time is established approximately in the same figures as for pipe Mir. From here it follows, that the deepest (down to 300 m) erosive cut of all kimberlite bodies of the region and country rocks took place in Pre-Late Palaeozoic time [3]. At this particular time the basic mass of kimberlite minerals was released, which then passed to productive horizons, since during Mesozoic denudation epoch (in Middle-Late Triassic) kimberlite bodies were eroded to depth almost an order less than in Pre-Late Palaeozoic (only 40 m), and in Cainozoic – approximately to the same value less (about 5 m). Basing on this established size of the erosive cut of pipe Mir and development of these or those stratigraphic horizons of Lower Palaeozoic the size of the supposed erosive washout of rocks on all the considered territory since the time of kimberlites intrusion prior to the beginning of Late Palaeozoic sedimentation is defined. The Most significant cut (400–500 m and more) is noted in the south of the region, within the limits

of paleowaterway valleys (Angara–Vilyuy sagging). From Mirny kimberlite field to the north, along the arch part of Botuobinsky uplift and Syugdzherskian saddle, the thickness of washout of rocks decreases from 300 to 200 m, and on their slopes – to 100 and less meters (within the limits of Alakit-Markhinsky kimberlite field – first tens of meters). During this peneplanation of the territory before the period of stabilization of tectonic movements and the epoch of crust-formation along the valleys of then existing paleowaterways and coastal zones of basins eroded kimberlite and terrigenous material accumulated, which subsequently redeposited in the sediments of Upper Palaeozoic [14].

The cited data allow assuming that Upper Palaeozoic depositions of a southern part of the region should contain considerably more kimberlite material than Mesozoic and Cainozoic ones. Favourable conditions for their accumulation in depositions of Upper Palaeozoic, as it was already was mentioned, are: 1) deep denudation cut of kimberlite pipes of the southern part of the region which took place in Pre-Late Palaeozoic time; 2) small probability of the removal of the basic mass of kimberlite minerals beyond the limits of Botuobinsky uplift. Fine-fragmental sand-silty-argillaceous composition of Lower Carboniferous formations, developed within the limits of adjacent with it parts of Tungusskaya syneclise (in the West) and buried ones of Ygyattinsky depression (in the East), point to it unambiguously. These formations were generated due to terrigenous material introduced here during the specified above significant washout of rocks, which had been developed on the given uplift. Depositions, in which the basic mass of kimberlite minerals is concentrated, released in Early Carboniferous period, should represent washout products of Middle Palaeozoic kimberlites, trapps and terrigenous-carbonate rocks of Lower Palaeozoic (mainly Ordovician and Silurian). Integrity of predicted productive horizons of Lower Carboniferous rocks within eastern border limits of Tungusskaya syneclise was provided with the fact that they were buried or under discrepantly lying deposits of Lapchanskian, Botuobinskian and Boruloyskian suites of Permian [12]. The finds of rounded to various degree grains of pyrope and picroilmenite in listed above stratigraphic horizons should be explained, mainly, by their rewashing and redeposition from Lower Carboniferous rocks. In early Mesozoic and Cainozoic these rocks practically were not washed away and did not participate in formation of productive horizons of Rhaetian–Early Jurassic and Quaternary age deposits. It is proved by ratio of [14] quantities of calculated by us kimberlite minerals in Mesozoic and Cainozoic deposits with the maintenance of liberated from eroded in Middle-Late Triassic and Cainozoic parts of kimberlite pipes. The volume of kimberlite minerals in given deposits exceeds their estimated quantity from eroded at this time parts of kimberlite pipes only 1,3 times, that can be explained by small additional feeding of these minerals from other (including still not discovered}) diamondiferous sources.

Distribution of these deposits, which have kept from washout, should be specified by erosion-tectonic depressions reconstructed within the limits of Botuobinsky uplift. It is possible that the formations of Lapchanskian suite within the limits of the uplift were suppliers of kimberlite material to basal horizons of Botuobinskian and Boruloyskian suite [5, 8, 11, 13] which have confirmed numerous rewashing of clastic material during formation of considered by us stratigraphic subdivisions of Upper Palaeozoic. Inflow of kimberlite minerals to the deposits of Lapchanskian suite from more ancient (Lower Carboniferous) formations is emphasized by significant degree of their mechanical wear which could not occur during redeposition of these minerals into the specified suite as it was generated in conditions of short-distance washdown of terrigenous material [1, 2,

12]. It means that accessory minerals acquired such shape during formation of still Lower Carboniferous deposits. Bad integrity and relatively wider areal distribution of haloes of dispersion in comparison with those for Lapchanskian suite testify about the further redeposition of considered kimberlite material into younger deposits (of Boruloyskian at first, and then Boruloyskian suites). In Late Palaeozoic only part of kimberlite minerals could be removed beyond the limits of Botuobinsky uplift and concentrated in thin conglomerates among sandstones of Permian within the limits of south-eastern wing of Tungusskaya syneclise. Probably the basic part of kimberlite minerals, which escaped from eroded parts of diatremes, should be within the limits of the specified uplift in productive horizons attributed to depositions of Lower Carboniferous, and on sites where they are washed away - to formations of Permian. As it was already mentioned above, the size of the erosive cut of rocks of Lower Middle Palaeozoic, including kimberlites, decreases from southern part of the region in northern direction. Accordingly, the volume of eroded and redeposited at first into Lower Carboniferous collector, and then into Upper Palaeozoic deposits of kimberlite material decreases in the same direction, that has its effect on formation conditions of productive horizons and prospecting of diamondiferous diatremes on them. Thus, scales of kimberlite material redeposition sharply decrease in Daldyn-Alakit kimberlite field at insignificant size of the erosive cut of rocks (first tens of meters). Therefore fragments of primary stray fluxes of these minerals are registered here among redeposited into Upper Palaeozoic formations of kimberlite minerals, on which prospecting of their primary sources is more successfully performed. With increase in the erosive cut of rocks similar stray fluxes are practically not revealed, and significant wear, numerous redeposition and removal of kimberlite minerals to various distances from their primary sources is noted, that considerably complicates their prospecting.

In turn, the received results of secondary minerals' investigations allow to specify the size of the erosive cut of many kimberlite pipes of Yakutia and other diamondiferous regions of the world, in addition to mentioned on the example of Upper Palaeozoic productive deposits' geological reconstructions. Thus, for example, the small erosive cut of pipes Aykhal, Yubileynaya, Sytykanskaya and other bodies of Daldyn-Alakit region is acknowledged by many geologists after the finds of layered kimberlite tuffs here of sedimentary-volcanogenic origin. Practically complete disappearance of quartz druses in such pipes at depth of several tens of meters from surface can be interpreted as the proof of their development namely in tops proper of poorly eroded kimberlite bodies. In such cases frequent finds of quartz and chalcedony druses in kimberlites of upper horizons of pipe Udachnaya may be considered as indirect evidence of weak erosive character of the pipe, which should be taken into account during forecasting and prospecting of diamond placers in this region. In turn, leaching of carbonates and magnesia silicates most intensively proceeded in upper apical parts of the pipes as well. The reason of this is in strong watering of specified parts of the pipes, and also in alteration of the solutions' composition caused by recession of temperature (participation of carbonic, hydrosulphuric and, probably, stronger acids and their salts). During dissolution of kimberlites, composed mainly by calcite and silicates of magnesium, there was neutralization of solutions with increase of pH, which stipulated the loss of new carbonates (basically dolomite and aragonite) and other secondary minerals originated from authigenic substance. Processes of dissolution repeated in upper horizons of the pipes, which is testified by dissolution forms of scalenohedral calcite [10]. Availability of spherulites of radial-concentric structure is typical of upper horizons of many pipes as well, which are composed by brown calcite.

Calcite of such spherulites is greatly ($\delta^{13}C$ up to 31,0–35,0 ‰) enriched by heavy carbon. Carbon of spherulites (autoliths) coordinates with magmatic stage of pipes formation [9]. Gas-liquid inclusions with T_{hom}=150–130 °C have been distinguished in thick-tabular brown calcite from spherulite centre. Besides gas-liquid impurities inclusions of liquid hydrocarbons were diagnosed, which according to form (shape) and interrelation with calcite are referred to primary ones.

1. *Afanasjev V.P., Zinchuk N.N.* Mineragenetic character of ancient diamonds placers of the eastern border of Tungusskaya syneclise // Geology and geophysics. 1987. N 1. P. 90–96.
2. *Afanasjev V.P., Zinchuk N.N.* Basic lithodynamic types of haloes of kimberlite indicator minerals and conditions of their formation // Geology of ore deposits. 1999. Vol. 41. N 3. P. 281–288.
3. *Boris Ye.I.* Mineralogical features of Upper Paleozoic deposits in connection with the problem of their placer diamondiferousness (Malo-Botuobinsky region of Western Yakutia) // Geology and minerals of Eastern Siberia. Novosibirsk, 1985. P. 159–164.
4. *Boris Ye.I., Ivaniv I.N.* Paleogeographic formation features of Upper Paleozoic productive deposits of Malo-Botuobinsky region // Geology and minerals of the south of Eastern Siberia. Irkutsk, 1974. P. 163–165.
5. *Kharkiv A.D., Zinchuk N.N., Kryuchkov A.I.* Geological-genetic basis of heavy concentrate-mineralogical method of diamond deposits' prospecting. M., 1985.
6. *Kharkiv A.D., Zinchuk N.N., Kryuchkov A.I.* Primary diamond deposits of the World. M., 1998.
7. *Saltykov O.G., Erinchek Y.M., Ustinov V.N., Mil'shtein E.D.* Late Paleozoic terrigenous collectors of diamonds of Tungusskaya syneclise eastern border. SPb., 1991.
8. *Taranenko V.I., Boris Ye.I., Kharkiv A.D., Zinchuk N.N.* Lithology and palaeogeographic of Upper Paleozoic deposits of the Vilyuy river middle current basin. M., 1975.
9. *Zinchuk N.N.* Crust of weathering and secondary changes of kimberlites of the Siberian platform. Novosibirsk, 1994.
10. *Zinchuk N.N.* Postmagmatic kimberlite minerals. M., 2000.
11. *Zinchuk N.N., Afanasjev V.P.* Genetic types and basic laws of diamondiferous placers' formation // News of Higher School. Geology and prospecting. 1998. N 2. P. 66–71.
12. *Zinchuk N.N., Boris Ye.I.* About concentration of redeposition products of crusts of weathering in Upper Paleozoic sedimentary terranes of the eastern border of Tungusskaya syneclise // Geology and geophysics. 1981. N 8. P. 22–29.
13. *Zinchuk N.N., Afanasjev V.P., Boris Ye.I.* Principle of diamondiferous territories' zoning according to accessory minerals of diamond // Forecasting and prospecting of primary diamond deposits. Simferopol', 1999. P. 36–41.
14. *Zinchuk N.N., Boris Ye.I., Yanygin Y.T.* Specific features of diamond mineragenetic character in ancient sedimentary terranes (on the example of Upper Paleozoic deposits of the Siberian platform). Mirny, 2004.

ВИКОРИСТАННЯ ВТОРИННИХ МІНЕРАЛІВ КІМБЕРЛІТІВ ДЛЯ ВИЗНАЧЕННЯ ЕРОЗІЙНОГО ЗРІЗУ КІМБЕРЛІТОВИХ ТРУБОК

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Наведено результати комплексного дослідження вторинних мінералів кімберлітів у зв'язку з можливістю їхнього застосування для визначення ерозійного зрізу кімберлітових трубок, що можна використовувати разом з геологічно-структурними дослідженнями. Малий ерозійний розріз діатрем (трубки Айхал, Ювілейна, Ситиканська та інші Далдино-Алакітського району Сибірської платформи) фіксують за наявністю шаруватих кімберлітових туфів осадово-вулканогенного походження у верхніх частинах проявів. Наявність потужних профілів кори звітрювання на верхніх рівнях вулканічних трубок також може свідчити про слабкий ерозійний зріз кімберлітових тіл. Практично повне зникнення друз аметистоподібного кварцу в таких трубках на глибині декількох десятків метрів від поверхні теж можна інтерпретувати як доказ їхнього розвитку у верхніх частинах слабко еродованих кімберлітових тіл. Часті знахідки кварцових друз, халцедону та інших новоутворень у кімберлітах верхніх рівнів трубок можна зачислити до непрямих доказів слабкого ерозійного зрізу трубок, що потрібно брати до уваги під час розшуків алмазних розсипищ у регіоні.

Ключові слова: кімберлітова трубка, вторинні мінерали кімберлітів, ерозійний зріз, алмази, Сибірська платформа.

Стаття надійшла до редколегії 07.05.2008
Прийнята до друку 30.10.2008