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EARLY PALEOZOIC COMPRESSIVE STRESS FIELD AND IMBRICATED THRUST STRUCTURES ALONG THE NORTH-WESTERN COAST OF LAKE BAIKAL (KHIBELEN CAPE)

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Abstract. - Detailed investigation of a sector of the Pribaikal fold-and-thrust belt along the northwestern coast of Lake Baikal allows a new insight in the structural evolution of Precambrian and early Paleozoic series, at the contact with the Siberian platform. The Khibelen area, 150 km south of the northern termination of Lake Baikal. is characterized by well exposed imbricated thrust structures. These are later dissected by late high-angle reverse faults, and then by strike-slip faults. The high-angle faults, together with the low-angle thrusts are likely to control the location of major rift border faults, during Cenozoic reactivation in a tensional stress field. The Pribaikal fold-and-thrust pattern is thought to have developped during a final stage of the Caledonian Central-Asian event, during late Silurian-early Devonian.

The relative succession of Paleozoic brittle deformations in the Khibelen area is : (1) low-angle thrusting, (2) high-angle reverse faulting and (3) strike-slip faulting. Paleostress tensors reconstructed from the analysis of minor faults and associated slip lines show the existence of at least two major stages in the kinematic evolution of stress field during Paleozoic. The oldest paleostress field obtained refers to the development of high-angle reverse fault, and the second, to the subsequent development of conjugated strike-slip faults. The first stress field is pure-radial compressive with a NW-SE principal direction of compression. It then evolved by a slight anticlockwise rotation of horizontal stress axes, together with a decrease in the relative intensity of the horizontal minimum compression, leading to strike-slip regime. This evolution of the stress field is not only valid for the area surrounding the Khibelen cape, but also for the whole length of the Pribaikal area, adjacent to the northwestern coast of Lake Baikal.

Résumé. - L'étude détaillée d'un petit secteur de la chaîne plissée de Pribaikal, le long de la côte nord-ouest du lac Baikal permet une nouvelle approche de l'évolution structurale des séries précambriennes et paléozoïques inférieures, en contact avec la plateforme sibérienne. La région du cap Khibelen, située 150 km au sud de la terminaison septentrionale du lac Baikal, est caractérisée par une structure en écailles imbriquées et plissées, particulièrement bien exposée. Cette structure est recoupée par des failles inverses à forte pente et des failles décrochantes. Les failles inverses et de chevauchement ont très probablement contrôlé la localisation des failles bordières majeures du rift cénozoïque, suite à la réactivation régionale dans un contexte extensif. La mise en place des nappes et la déformation associée à la chaîne Pribaikal sont rattachées à un stade final de l'événement Calédonien d'Asie Centrale, durant le Silurien tardif et le Dévonien précoce.

La succession relative des déformations cassantes du Paléozoïque est : (1) chevauchements à faible pente, (2) fracturation inverse à forte pente et (3) fracturation décrochante. Les tenseurs de paléocontraintes, reconstruits à partir de l'analyse des failles mineures avec stries, montrent l'existence d'au-moins deux stades d'évolution cinématique du champ de contrainte au Paléozoïque. Le premier état de paléocontrainte obtenu se rapporte au développement des failles inverses fortement pentées, et le second à celui des failles décrochantes. Les premières correspondent à un état de contrainte compressif, pur à constructif, avec une direction NO-SE de la contrainte compressive principale. Par la suite, ce champ a évolué en un régime décrochant, suite à une décroissance de l'intensité relative de la contrainte horizontale minimale, accompagnée par une légère rotation antihorlogère des axes horizontaux. Cette évolution du champ de contrainte n'est pas restreinte à l'environnement du cap Khibelen, mais elle est également valable pour toute la partie de la chaîne Pribaikal qui est longée par la côte nord-ouest du lac Baikal.

Samenvatting. - Een nauwkeurige studie van een sektor in de Pribaikal plooi- en overschuivingsketen die zich uitstrekt langsheen de noordwest kust van het Baikal meer, geeft een nieuw inzicht in de strukturele evolutie van het Precambrium en van het vroeg Paleozoïcum, in de contact zone met het Siberisch platform. Op 150 km ten zuiden van de noordelijke grens van het Baikal meer is de streek van Khibelen gekenmerkt door wel ontsloten schub-strukturen, doorsneden door steilhellende inverse- en strike-slip breuken. De steilhellende breuken, samen met de zwak hellende over-

schuivingsbreuken, hebben zeer waarschijnlijk de schikking van belangrijke rift breuken gekontroleerd tijdens de Cenozoïsche reactivatie in een extensief krachtenveld. De Pribaikal plooi- en overschuivingsketen zou overeenkomen met een uiteindelijk stadium in de Caledonische Centraal Asiatische evolutie in laat Siluur-vroeg Devoon.

Paleostress tensoren, afgeleid uit de analyse van kleinere breuken en geassocieerde sliplijnen wijzen op het bestaan van minstens twee belangrijke stadia in de kinematische evolutie van het spanningsveld. Het paleo-spanningsveld van de overschuivings- en plooivervorming werd niet bepaald. Beschikbare paleostress data hebben betrekking op de ontwikkeling van steilhellende inverse breuken en hierop volgende ontwikkeling van geconjugeerde strike-slip breuken. Het eerste spanningsveld is zuiver radiaal kompressief met een NW-SE hoofdrichting van kompressie. Dit veld evolueert vervolgens door een zwakke antikloksgewijze rotatie van de horizontale spanningsassen, samen met een afname van de relatieve intensiteit van de horizontale minimale spanning, wat leidt tot een strike-slip regime. Deze evolutie van het spanningsveld is niet alleen geldig rond de Khibelen kaap, maar eveneens voor de hele lengte van de Pribaikal zone langsheen de noordwest kust van het Baikal meer.

1. INTRODUCTION

The major objectives of the CASIMIR project is to study the Cenozoic rift structural evolution, in relation to pre-existing structural lines of weakness. The northwestern margin of the Lake Baikal depression follows clearly the trend of pre-rift structures associated with the Pribaikalian fold-and-thrust belt, which developed at the contact with the Siberian Craton (fig. 1), during the Paleozoic evolution of the Central Asian Fold Belt (Alexandrov, 1990). When looking for microstructural indications of Cenozoic rift faulting in this area, it was realized that most of the rift major border faults outcrop mainly under water. Despite of this nearly all the outcrops visited along the north-western coast of Lake Baikal showed the presence of numerous minor faults with well expressed slip lines. However, the minor faults generally display reverse to strike-slip types and some of them are clearly associated with meso-scale thrust structures. These minor structures were investigated in detail with the aim to reconstruct the associated reduced paleostress tensors.

A general synthesis of the results of paleostress analysis on 22 sites distributed along the whole 600 km length of the northwestern coast of Lake Baikal has been presented elsewhere (Delvaux, 1993). It shows that the kinematic evolution of the Pribaikal area is characterized by the presence of two compressive stress regimes, which mainly differ by the orientation of the horizontal principal stress axes. The better expressed stress regime (fig. 2a) is characterized by a dominant NW-SE principal direction of compression,

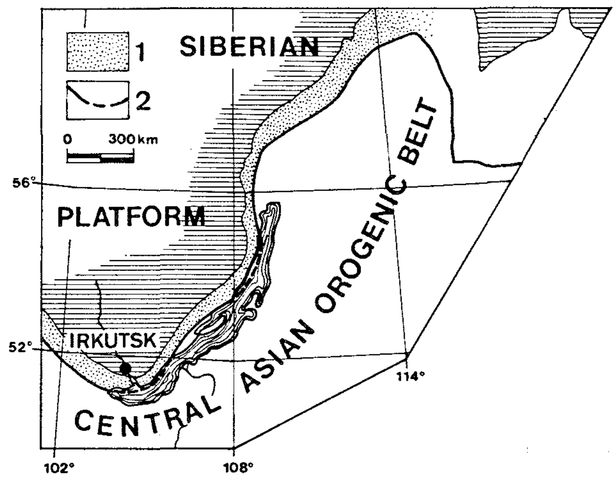

Fig. 1. - General tectonic scheme of the basement of the Baikal rift zone. 1 : Pribaikalian fold-and-thrust belt; 2 : tectonic boundary of the Siberian Platform (Main Sayan - Primorskiy - South Baikal dislocation zone).

and is of dominant compressive type. The second stress regime (fig. 2b), which is expressed more locally, has a dominant horizontal WNW-ESE principal direction of compression and is intermediate between strike-slip and compressive types. They caused strike-slip and reverse or thrust faulting at micro to meso-scale. The relative timing of these two kinematic episodes is not yet well constrained, but the detailed analysis presented in this article shows that the NW-SE compressive regime should be the earliest, and WNW-ESE strike-slip to compressive regime should be the latest. Both regimes strongly correlate with the major compressive phase that caused imbricated thrusting from east to west, against the eastern border of the Siberian Craton, superimposing lower Proterozoic over late Proterozoic and late Proterozoic over early Paleozoic.

Since most of the basic literature on the discussion of field data is exclusively in Russian, it was of interest to concentrate on the detailed description of a well exposed area of this long Pribaikalian belt. The following discussion concerns the local stratigraphy and structure of the Khibelen cape, situated 150 km south of the termination of Lake Baikal, along its north-western coast, between the Bolshoy Cheremshany and Malaya Kosa Capes (fig. 2, 3).

The considered area is situated in the marginal part of the Siberian platform, at the contact zone with the Sayan-Baikal fold belt (fig. 1). The structure of this area is known through general geological mapping. The first results are from the works of Pavlovsky (1948) and Salop (1964). They form the basis for subsequent regional models. Chesnokov (1978), who studied fold deformations and the nature of contacts between Precambrian complexes, came to the conclusion that folding in this area and in the whole Pribaikal Region corresponds to the cascade type, resulting from gravity tectonics during Mesozoic. Although this point of view is generally no more supported, it initiated the discussion about the timing and the mechanism of folding and thrusting in this area. At present, the question of the role of thrust faults in the general structural evolution remains incompletely solved, although thrust geometries can be easily reconstructed along the northwestern coast of Lake Baikal (Alexandrov, 1990). The apparent structural complexity, together with the quality of exposure, determined the choice of this area for a detailed structural investigation.

2. GEOLOGICAL AND STRUCTURAL CONTEXT

The Pribaikal fold-and-thrust belt form part of the large Central Asian late Precambrian - early Paleozoic orogenic belt (Peive *et al.*, 1976). It forms a Cadomian fringe at the southeastern margin of the Siberian-Baikal Craton, between the Siberian platform and the Sayan-Baikal belt. The latter constitutes the eastern extremity of the Central Asian belt, originated from the closure of the eastern part of the Paleoasian ocean (Belichenko, 1977; Mossakovsky and Dergunov, 1985; Belichenko *et al.*, 1993). Stratigraphic sequence of the Central Asian Caledonides comprises the Proterozoic, the entire Cambrian, Ordovician and the lower Silurian. During the tectonic history of the Central Asian Caledonides, intense folding and thrusting occur in many places, between late Ordovician and the end of the late Silurian. After the last regional deformation at the end of the Silurian, lower to middle Devonian red terrestrial molasses were deposited, locally mixed with volcanics.

Geomorphologically the area of the Khibelen cape belongs to the Pribaikal Range which forms the northwestern shoulder of the Baikal rift basin. The Pribaikal Range is strongly asymmetric, with a gentle north-western slope and a steep south-eastern slope corresponding to the Baikalskiy rift scarp. Relative height of the range in this area is about 1300 m above the lake level.

The southeastern slope of the Pribaikal Range (fig. 3) is made up of early, middle and late Proterozoic rocks (Salop, 1964; Bukharov; 1987; Zamaraev *et al.*, 1975; Geochronology of Precambrian , 1968).

2.1. Early Proterozoic

The early Proterozoic complex is represented by metasediments and metaeffusive rocks of greenschist facies, with sandstones and occasional thin layers of carbonate and quartzites. Observed thickness of the early Proterozoic complex is more than 1500 m. The volcanosedimentary formations are intruded by early Proterozoic plagiogranites and granodiorites. Contacts between the granitoids and the enclosing rocks are both concordant and discordant. The granitoids are generally foliated, with blastomylonitic and cataclastic textures, under greenschist conditions.

The early Proterozoic is complexely dislocated as shown by the development of pervasive foliation, boudinage and a great number of micro- and macrofolds. Large scale folds are not observed directly, but they can be reconstructed from isolated outcrops. Detailed structural investigation of microfolds reveals at least two stages of deformation that resulted in the development of imbricated synforms and antiforms. Folding has a general NE trend which is typical for the whole area.

2.2. Middle Proterozoic

Early Proterozoic formations are unconformably overlain by transgressive middle Proterozoic series. The relations between early and middle Proterozoic series are observed not only along the coast, but also in the Pribaikal Range itself. In a number of exposures along the Baikal coast, north of the Khibelen Cape, basal conglomerates up to 8 m thick lie upon cataclastic early Proterozoic plagiogranites (Salop, 1964). These conglomerates are overlain by various sandstones and siltstones. In the middle course of the Khibelen river, along its left tributary, middle Proterozoic terrigenous formations overlie early Proterozoic green-grey plagiogranites. The basal layers are characterized by grey arkosic inequigranular sandstones with a maximum thickness of 10 m. The contact surface dips steeply (70°) north-westwards. The sandstones are overlain by cherry-coloured, indistinctly bedded siltstones and tuffs with a visible thickness of 40 m. Stratigraphically, siltstones are overlain by dark grey felsic porphyries which are part of an extrusion passing into leaf-by-leaf sill. Upper levels of middle Proterozoic are found in this area only in the axial part of the Pribaikal Range. They are represented by terrigenous formations, dominated by sandstones and conglomerates with horizons of siltstones. Felsitic quartzporphyries of 250 m thick form the top of the middle Proterozoic section.

Middle Proterozoic terrigenous formations are characterized by variously coloured cross-bedded structures, with sharp variations of facies. This makes the correlations between horizons from remote exposures difficult. The total thickness of the middle Proterozoic

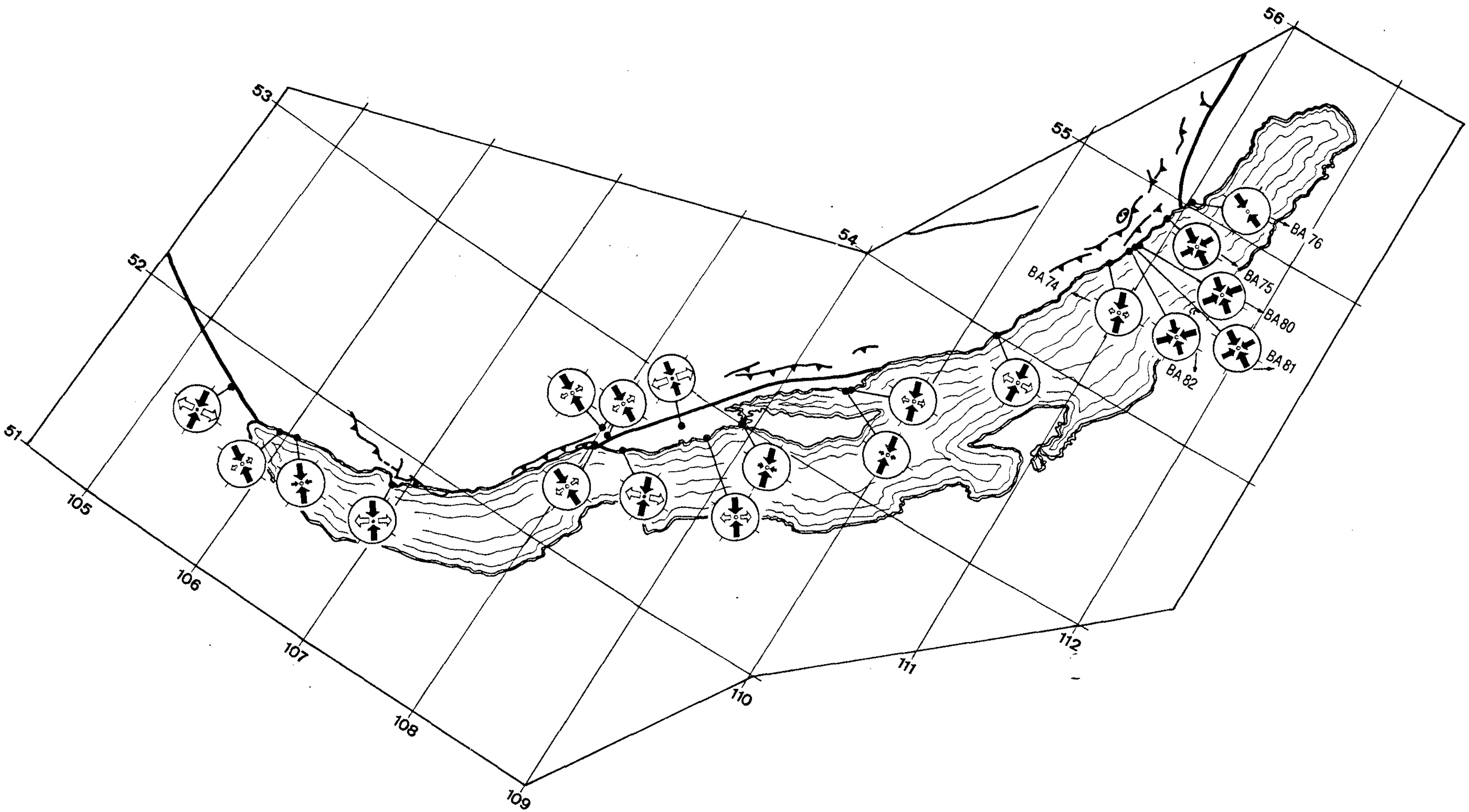

Fig. 2A. - Simplified structural map of the Pribaikal area with symbols indicating the orientation and relative magnitude of the horizontal principal stress axes for two successive episodes of early Paleozoic deformation.
NW-SE horizontal principal compression.
Black inwards arrows indicate compressive stress and white outwards arrows indicate extensive stress axes, with their length according to their relative magnitude, as indicated by the stress ratio R. The vertical stress axis is symbolized as a small central circle, white for compressive regime ($\sigma 3$ vertical) and black for strike-slip regime (σ 2).

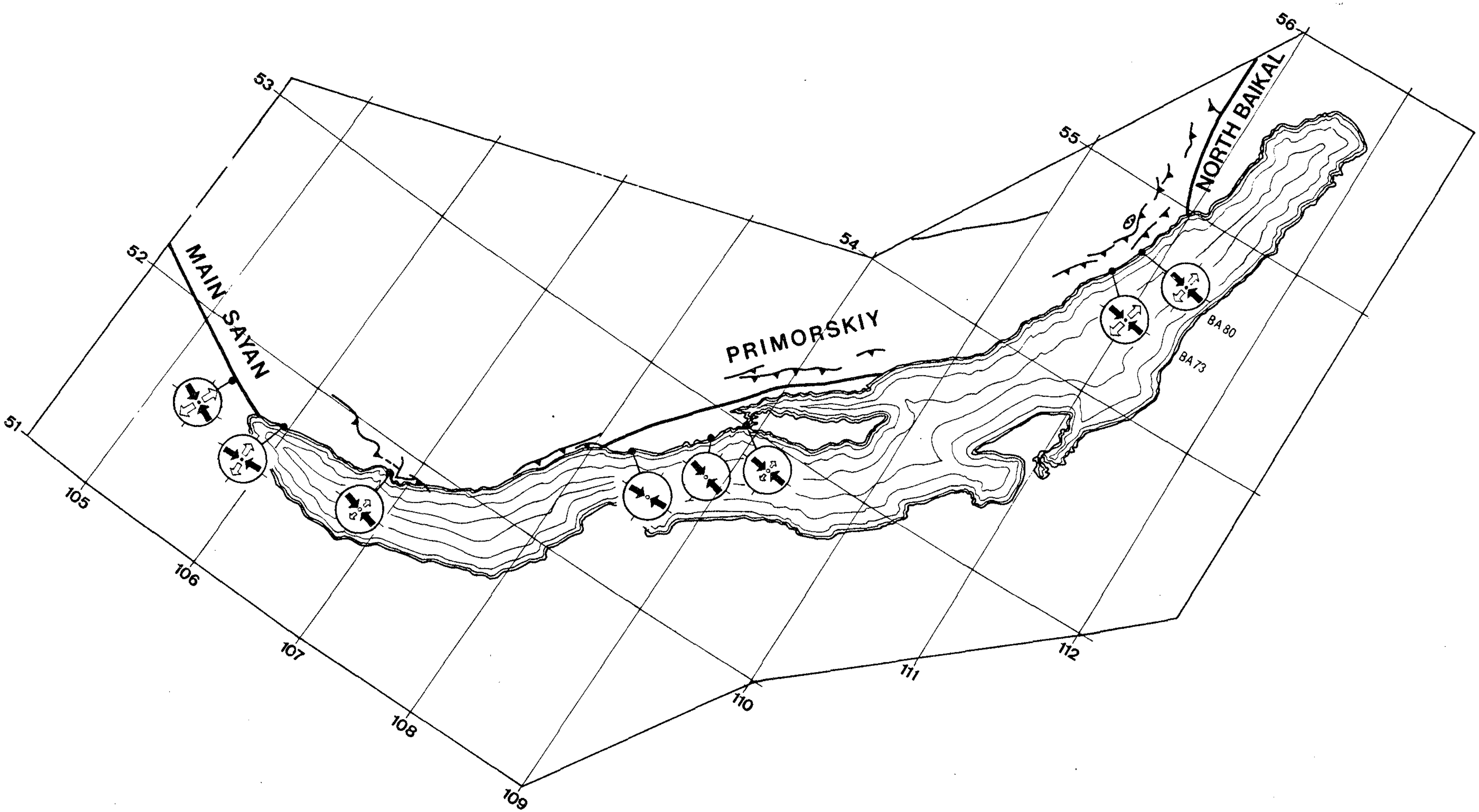

Fig. 2B. - Simplified structural map of the Pribaikal area with symbols indicating the orientation and relative magnitude of the horizontal principal stress axes for two successive episods of early Paleozoic deformation.
WNW-ESE horizontal principal compression.
Symbols as in figure 2A.

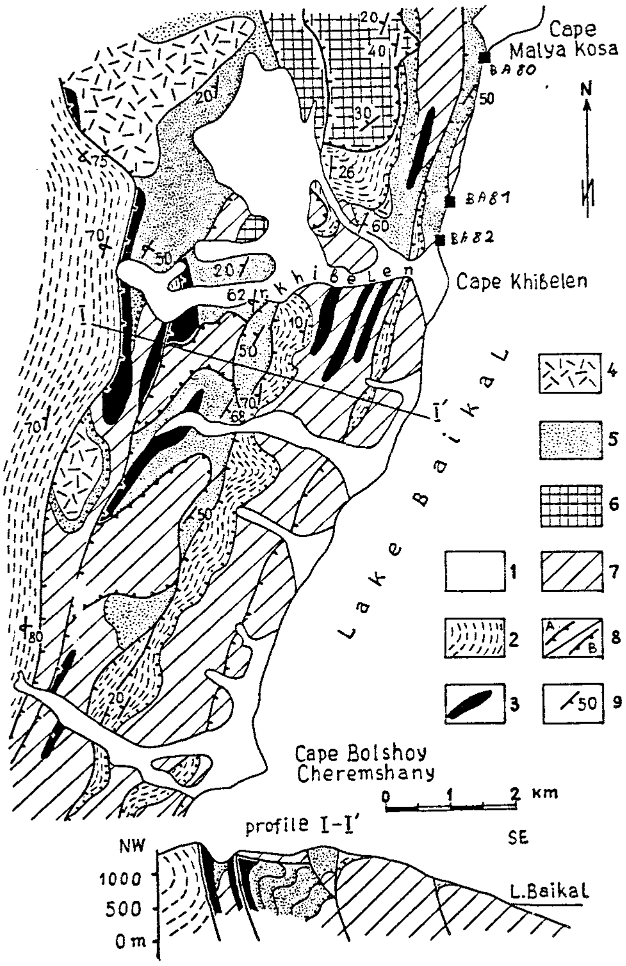

Fig. 3. - Geology and structure of the Khibelen area, along the northwestern coast of Lake Baikal.
1 : Quaternary deposits; 2 : upper Proterozoic (Baikalian series); 3-5 : middle Proterozoic; 3 : gabbro; 4 : felsitic porphyries; 5 : terrigenous rocks; 6-7 : lower Proterozoic; 6 : meta- volcanosedimentary deposits; 7 : granitoids; 8 : faults; A : high-angle; B : low-angle; 9 : bedding. Location of sites of microstructural analysis for paleostress determination.

section may be roughly evaluated to 1800-2000 m. Rb-Sr dating or porphyries in the adjacent areas of comparable structural context yields an age of 1620 ± 40 Ma (Bukharov, 1987). The volcanosedimentary formations are intruded by gabbros which are believed to have developed in the final stages of middle Proterozoic structural evolution. These intrusions are composed of steeply dipping NE-striking dykes of up to 300 m thick.

Bukharov (1973) infers that the internal structure of the middle Proterozoic is only weakly deformed. However, new data indicate the presence of large fold structures. A prominent example of this is a fragment of a fold observed in the right slope of the Khibelen river (fig. 4). The fold is overturned in a north-western direction, with an apparent amplitude of 300 m. Microstructural observation of cleavage orientation with respect to bedding at the base of an obliquely laminated block, confirms the presence of a fragment of a large synclinal whose axial plane is overturned to NW and fold axis plunges 10-20° to the SW.

A fragment of an anticlinal structure of the same size can be reconstructed in the axial part of the Pribaikal Range, along the left slope of the Khibelen river, west of the above described structure. Judging from the position of bedding, the established structure is tilted northwestwards at an angle of 50°. Moreover, north of the study area in the middle course of the Malaya Kosa river, similar structural trends were also mapped (Salop, 1964). These data point to the presence of large-scale dislocations within the middle Proterozoic formations which contradicts the existing opinion (Bukharov, 1973) that these series are only weakly deformed.

2.3. Upper Proterozoic - Lower Paleozoic

Upper Proterozoic series in the studied area overlie middle and lower Proterozoic in erosional and angular unconformity (Salop, 1964; Bukharov, 1973, 1987). the lowermost layers of the upper Proterozoic (Baikalian series, Riphean) consist of quartz conglomerates and gravelstones which evolve upwards to quartz sandstone with interbedded shales and limestones. In the Pribaikal Range itself, the visible thickness of the upper Proterozoic beds does not exceed 200 m. On its western slope, the Baikalian series reach a total thickness of 800 m and are overlain discordantly by the Vendian-Cambrian formations.

At present, upper Proterozoic rocks at the eastern slope of the Baikal Range occur in narrow 1.5 km wide, tectonic blocks bounded on one side by NE-trending faults, subparallel to the Baikal shoreline. The altitude of the base of the Baikal series differs in the fault bounded blocks, tending to a stepwise lowe-

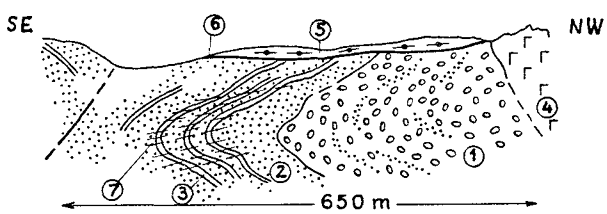

Fig. 4. - Detail of a section along the left slope of Khibelen river, showing a thrust surface cutting and underlying fold structure in the middle Proterozoic. 1 : conglomerate; 2 : inequigranular sandstones; 3 : siltstones; 4 : gabbro; 5 : early Proterozoic mylonitic plagiogranites; 6 : fault surface; 7 : cleavage.

ring from the axial part of the Range to the shore of Lake Baikal. The Baikalian series in these blocks plunge gently NW, and minor folds with amplitude up to 15 m are observed. These folds are of flexural type and overturned to the NE, with axial lines gently plunging to the NE. They are well expressed at some distances from the contact with the underlying middle Proterozoic series and they are gradually flattening upwards in the direction of the present-day erosional surface. In addition, the dipping of the Baikalian series evolve from low-angle to vertical and even to the overturned position, at the vicinity of major thrust faults, thus tending to parallelism with the fault planes. Upper Proterozoic series are characterized by an unidirectional structural asymmetry, expressed by the general overturning of the folds to NW.

3. MAJOR FAULT SYSTEMS

The fault pattern of the Khibelen Cape is characterized by the successive development of low-angle thrusts, followed by high-angle reverse faults. The latter are dissected by later strike-slip faults. In addition, the high-angle reverse faults were reactivated as normal faults during Cenozoic extension.

3.1. Thrusts faults

Early Proterozoic formations were thrusted over middle and upper Proterozoic series, along low-angle faults. The best example comes from the right bank of the Khibelen river, where a low-angle fault cuts the overturned flank of a recumbent syncline, separating early and middle Proterozoic rocks (fig. 4). The residual thickness of the thrust sheet, after erosion, amounts to 100 m. The base of the sheet is characterized by strongly deformed plagiogranites, which evolved into banded mylonitic schists. The axial orientation of minor folds and the dipping of their axial surfaces evidence convincingly that the thrust sheet has been transported to the NW (N300°E). This is confirmed by the textural pattern of stretched porphyroclasts in the banded plagiogranites. A late development of kink bands in the mylonite schists, of both single and conjugate types reflect a more shallow stage of deformation, in a continuous process of tectonic deformation.

A analysis of kink band structural parameters indicates that, during the final stage of the thrust emplacement, the maximum compressive stress was still subhorizontal, with a NW orientation (N300°E, fig. 5). This is fully compatible with the direction of tectonic transport determined from stretched porphyroblasts.

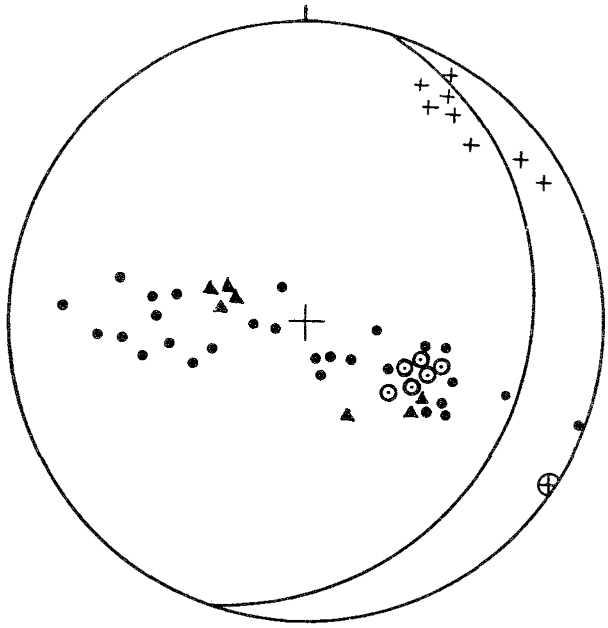

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Fig. 5. - Stereogram of structural elements from middle Proterozoic meta-sediments (upper hemisphere, Wulff net). 1 : poles of bedding; 2 : poles of cleavage; 3 : fold axes; 4 : poles of kink-bands; 5 : inferred direction of maximum compressive stress.

The geographical extent of the remnants of the allochtonous early Proterozoic suggests that they belong to a large thrust sheet rooted in the basement of the actual Baikal depression and moving to the NW. The total amplitude of displacement is impossible to reconstructed.

3.2. Reverse faults

A series of NE-trending high-angle reverse faults, running parallel to the lake shore, cut and displace the low-angle thrust faults. They are characterized by considerable lengths and can be traced throughout the area (fig. 3). The tectonized zones are thin, with a maximum 30 m thickness and they are represented by cataclasites and mylonites. Sedimentary strata are dragged near the fault zones. The fault surfaces inclined to the SE and irregularly curved, For example, the surface of the major fault, cutting the entire area, presents along-strike variations of dip angle, from a SE inclination to the vertical, and even to a NW inclination. This fault might be listric in cross section and one can extrapolate that a greater depth (15-18 km), individual fault surfaces may merge into a single subhorizontal decollement surface.

Formation of low-angle thrust and high-angle faults might have occurred in the middle Paleozoic and could be genetically related to foreland deformation of the Sayan-Baikal fold belt, that marked the end of the collision against the Siberian Craton (Alexandrov, 1990). In the Pribaikal area, at the fringe of the Siberian Platform, deformation started by low-angle faulting. It dissected the Precambrian rocks into a number of thrust sheets that resulted in an imbricated thrust structure. These motions produced tectonic dislocations in previously undeformed middle and upper Proterozoic rocks. It is likely that early Precambrian complexes also participated in this process. Then, after intense thrusting and folding, reverse faults developed, probably due to a modification of stress regime, or due to the locking of the imbricated structure.

3.3. Strike-slip faults

In addition to the widely developed reverse faults, some high-angle faults present dominantly lateral movements. An example of a conjugated set of strike-slip faults is well expressed outside the investigated area, along the Elokhin river (Elokhin strike-slip fault). The Elokhin fault strikes WNW-ESE, at right angle to the general trend of the Pribaikal belt, and presents a strong component of right-lateral movement. The magnitude of displacement is impossible to estimate, due to the absence of reliable markers. It is associated with a conjugate left-lateral fault of NNE-SSW trend. Kinematic analysis of associated minor faults planes and slip lines area allow to reconstruct a strike-slip stress field, with a WNW-ESE (N 280° E°) subhorizontal principal compression.

3.4. Normal faults

In Cenozoic, the high-angle reverse faults were preferably rejuvenated by normal movement, controlling the development of rift major border faults (Zamaraev and Ruzhich, 1978). Kinematic investigations show that the central portion of the Baikal rift evolved mainly under tensional stress field, with NW-SE subhorizontal principal extension axis during rift evolution (Sherman, 1992; Delvaux and Levi, *in press*).

4. PALEOSTRESS FROM MINOR FAULT ANALYSIS

Kinematic analysis of minor faults and associated slip lines in seven different outcrops between the Kotelnikosky and Elokhin capes along the north-western coast of Lake Baikal allow to propose a succession of two dominant paleostress regime associated with the structuration of the Pribaikal area.

The paleostress tensors were reconstructed using the TENSOR program (Delvaux, *in prep.*). Fault plane and slip line orientation, including slip sense are used to compute the four parameters of reduced stress tensors, as defined in Angelier (1989); the principal stress axes $\sigma 1$ (maximum compression), $\sigma 2$ (intermediate compression) and S3 (minimum compression) and the ratio of principal stress differences R ($\sigma 2$-$\sigma 3/\sigma 1$-$\sigma 3$). These are determined using firstly an improved version of the Right Dihedron method of Angelier and Mechler (1977), and then by minimization of the angular deviation between observed slip lines and computed shears for each fault planes, with maximization of friction coefficients.

The obtained paleostress tensors are listed in table 1, and illustrated in figures 6 and 7. They are grouped according to their similarities in function of stress regime and stress axis orientation, and classified chronologically according to the above structural evolution.

The first phase appears to be characterized by a compressive regime, intermediate between a pure compression and a radial compression. The principal compression axis ($\sigma 1$) is horizontal, with a NW-SE orientation (N125-305°E) and the principal extension axis ($\sigma 3$) is subvertical (fig. 8a). This principal direction of compression correlates well with the direction of tectonic transport of the thrust nappes and also with the approximate direction direction of compression obtained from the analysis of kink bands. However, this regime corresponds mainly to the development of high-angle reverse faults, rather than to the formation of thrusts. This is first indicated by the fact that the outcrops where the minor faults were measured are all located along the coast, in an area mostly affected by high-angle reverse faulting. It is also clear from the detailed stereonets and rose diagram (fig. 6), that the dominant dip of minor fault planes is between 60 to 80°, except for the Kotelnikoskiy cape, where conjugated low-angle minor faults dip between 30 to 40°. Finally, in most outcrops, relatively steeply inclined cleavage planes are clearly seen to be reactivated.

Therefore, this compressive stress regime do not corresponds to the first deformational episod, during which thrusting, folding and cleavage development occurred. It is the first paleostress regime recorded, as brittle microstructures, and it most probably corresponds to the reverse high-angle faulting episod. The stress regime related to the thrust emplacement could not be determined from the available data. This may be the consequence of the location of the observations along the coast, too far away from the major thrust faults. It is also possible that the deformation related to thrusting, folding and cleavage development was still in a semi-ductile regime, and that brittle structures from this episod are weakly expressed.

Table 1. - Parameters of the reduced paleostress tensors obtained on minor fault populations along the northwestern coast of Lake Baikal.

Paleostress regime 1

Outcrop	Area	n	sigma 1	sigma 2	sigma 3	R	alpha	Tensor type
BA76	Kotelnikoskiy	30	12/117	01/022	78/292	0.49	9.71	Pure Compressive
BA75	Muzhinai cape	5	11/123	06/031	78/271	0.91	2.64	Radial Compressive
BA80	Malaya Kosa	19	04/307	22/038	69/205	0.95	8.97	Radial Compressive
BA81		23	03/122	16/031	74/222	0.91	13.47	Radial Compressive
BA82	Khibelen cape	28	13/046	09/314	74/189	0.92	11.55	Radial Compressive
BA74	Elochin cape	9	08/161	35/256	54/060	0.27	8.96	Pure Compressive
Weighed mean tensor		114	03/125	12/033	78/227	0.75	Semi - Radial Compressive	

Paleostress regime 2

Outcrop	Area	n	sigma 1	sigma 2	sigma 3	R	alpha	Tensor type
BA80	Malaya Kosa	17	11/282	63/034	25/187	0.20	13.72	Compr. Strike-slip
BA73	Elochin cape	19	13/279	58/167	29/016	0.42	11.03	Pure Strike-slip
Weighed mean tensor		36	12/281	77/111	02/011	0.32		Pure Strike-Slip

n : number of selected fault datum, sigma 1-3 : orientation of stress axis (plunge/trend), R : stress ratio, alpha : mean deviation angle between observed slip striae and theoretical shears.

The two remaining strike-slip tensors (fig. 7) define a second paleostress regime, with a WNW-ESE (N101-281°E) horizontal principal compression and a subvertical intermediate axis (fig. 8b). This regime is younger than the pure-radial compressive regime. It caused mainly dextral strike-slip movements along NW-SE faults that cut across the dominant NNE trend of the high angle reverse faults. One of the sites where the strike-slip tensors were determined is the Elkhin cape, described above and the other is near the Malaya Kosa cape, where strike-slip faults are superimposed on high-angle reverse faults.

The extensive stress regime related to Cenozoic rift faulting is not well documented in this area, because the major rift border faults are located principally under water, following closely the coast line. The trace of the rift faults are only seen in small deltaic cones constructed by the rivers flowing into the lake, where they displace recent alluvial deposits. They developed in an extensive stress regime, with a dominant principal direction of extension oriented NW-SE, at high angle to the general strike of the rift (Delvaux and Levi, 1993).

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