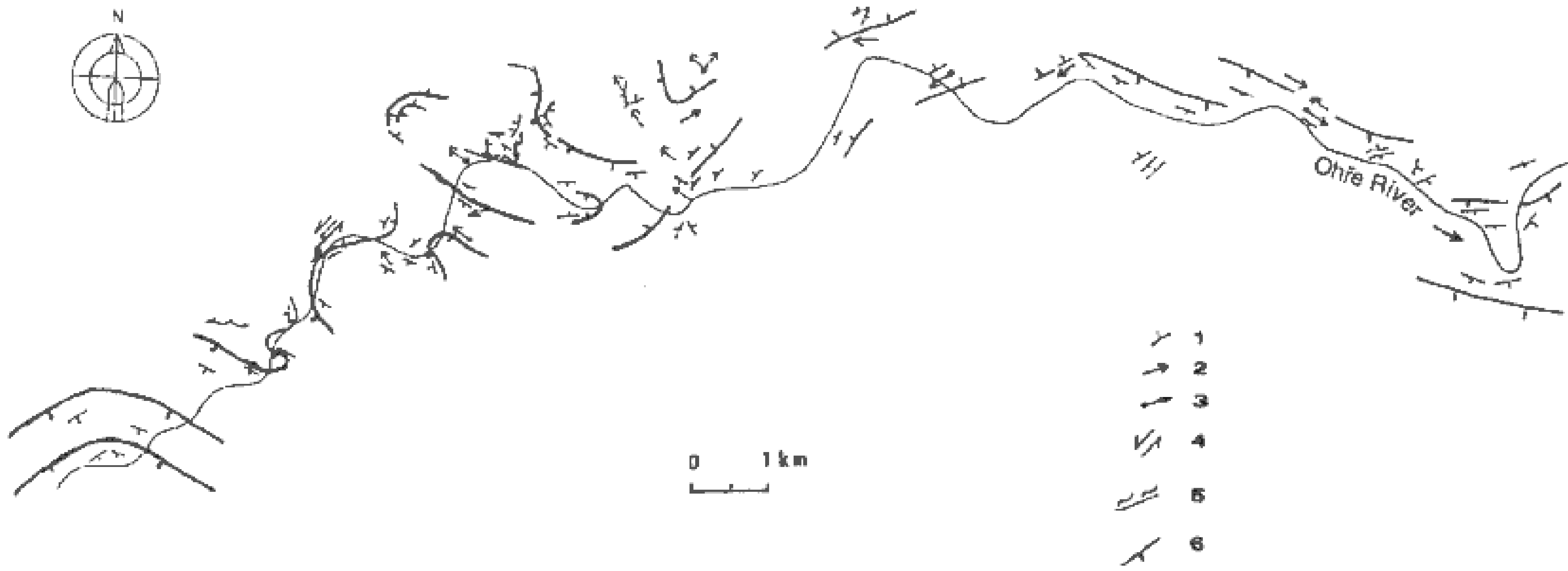

Fig. 4.1 Tectonic sketch of the Ohře crystalline area. 1 - foliation, 2 - fold axis, 3 - mineral lineation, 4 - sense of shearing, 5 - mylonite zone, 6 - interpretation of larger structures.

4. Main structures

Ohře crystalline complex (area A)

The dominant structure in granulites is a steep or upright 'regional foliation' (S_{reg}), generally E-W trending. It is represented by lithological banding on mm-m scale, with bands of light, quartzo-feldspathic rocks alternating with dark, more pelitic ones. This foliation was formed under granulite-facies conditions of metamorphism, as documented by garnet and kyanite crystallization. It was reactivated under amphibolite facies conditions, when a biotite ± muscovite foliation (± platy quartz) subparallel to the lithological banding formed.

The rock assemblage underwent a strong deformation, which resulted in formation of angular boudins of the dark material surrounded by the light rocks, and ductile shearing and folding of the bands of the light material. No intrafolial folds were observed in sites of contrasting lithologies.

Zones of intense small-scale folding (even biotite foliation folded) on cm-dm scale are associated with later zones of fracturing and alteration (Kamenec profile, Kotková 1992). In these zones, the rock foliation was locally crosscut (and obliterated) by shear zones, which contain anatectic melts (commonly kyanite-bearing). At the same time, the melt occurs parallel to the foliation of the rocks.

The S_{reg} is gently folded into open, generally symmetrical folds of dm - m scale. Their axes are mainly subvertical, south-plunging, less commonly subhorizontal, east or west-plunging.

Brittle shear zones that formed in the late stages of the evolution indicate normal faulting under lower grade metamorphic conditions in granulites. Late stage of the evolution is represented by intrusions of undeformed, tourmaline-bearing granite veins.

The structures observed in granulites document a high viscosity contrast of the felsic and pelitic material, and can be interpreted as a result of strong flattening (forming subvertical foliation and boudins) and ductile shear deformation (subvertical extension).

The main foliation in orthogneisses from the central part of the area A developed at amphibolite-facies conditions, and is defined by biotite and muscovite. It is generally steep, E-W (NW-SE)-trending, refolded into open folds with generally steeply dipping axes (58° to subvertical), commonly strongly crenulated. Relicts of intrafolial folds, and observed rather flat-lying foliation (S_1) with only incipient axial planar cleavage formation indicate that at least one deformation phase preceded the formation of the main foliation (S_2).

The main foliation (S_2) in migmatites corresponds to alternating bands of mica-rich (biotite > muscovite) melanosome, and mica-poor leukosome, of mm-dm thickness. This foliation is generally steep, with mainly NE-SW trend. Local NW-SE direction of the foliation results from folding on metric scale. Intrafolial folds were observed, too. Formation of the younger more shallow-dipping foliation (S_3) is commonly associated with development of shear bands, indicating top-to-NNE trend of shearing, in other sites with disharmonic folding.

Lineations can be observed very rarely in the migmatites and orthogneisses, due to high temperature recrystallization and migmatization of the rocks. Three types of generally subparallel linear structures occur: biotite and muscovite mineral lineations, striations, and fold axes.

The general trend of the foliations in the major part of the area is E-W, corresponding to the KHM crystalline area in the northwest. In the SW part of the outcrop area, foliations form a fan-like structure (Fig. 4.1). A large-scale fold deforming this foliation in the central part of the area is associated with an east-west trending zone of intensively deformed mylonitic orthogneisses. Evolution from planar-linear to linear fabric with rotational effects on these lineations are associated with heterogeneities and intensity of deformation in the shear zone.

Scheme of the structural evolution of the area is given in Tab. 4.1.

Zone Blahuňov - Málkov

In contrast to the area A granulites, granulitic gneisses from the Blahuňov - Málkov zone show well developed S-L fabrics. The main foliation is defined by kyanite ± garnet (minerals representing the early granulite assemblages), quartz ribbons and retrograde muscovite. As such, it is considered to have been formed under

Table 4.1 Deformation history of granulites and adjacent rocks

	granulites	orthogneisses	migmatites
D_1	S_1 G facies boudinage HP partial melts in shear zones	S_1 intrafolial folds ? A - G facies	
D_2	S_2 amphibolite facies coaxial with S_1		
D_3	ductile folds F_3		
D_4			S3 shear bands
	ductile-brittle shear zones		

Table 5.1 Nomenclature of granulites used in the work

petrology	geochemistry (SiO_2,group)	typomorphic minerals
felsic	acid (>69 %; A)	Qtz,Pl,Kfs,Grt,Ky
metapelitic	subacid (<69 %; B_2)	ditto
pyroxene-bearing	intermediate - basic (<69 %; B_1)	Pl,Grt,Cpx

granulite - facies, and reactivated under amphibolite - facies conditions. The foliation is generally east-west trending (Fig. 3.2), parallel to the lithological boundaries, and steeply north-dipping (dip 65-80°).

Lineations - mineral lineations (Ms, Qtz), fold axes, and striations - are generally subparallel, with E-W direction; their plunge is variable, ranging from subhorizontal to 40° (Málkov) up to 70° (Zelená).

5. Crustal assemblages

5.1 Petrology, mineralogy

Polyphase heterogeneous deformation (see below) resulted in formation of many structurally variable rock types. Based on lithological criteria, three main groups of granulite rocks have been distinguished: felsic (light, quartzo-feldspathic), metapelitic (darker), and pyroxene-bearing (dark) ones. The three rock types have acid, sub-acid and intermediate to basic chemistry, respectively (Kotková 1992; Tab. 5.1). Each of them includes several types, differing mainly in mineral proportions (ibid.).

A typical feature is the alternation of felsic and metapelitic rock layers. Dominant felsic granulites commonly form separate morphologically distinct and isolated outcrops with rather conspicuous jointing. They are generally massive and devoid of any macroscopic foliation. Granulites of the area B are exceptional, being very well foliated. Metapelitic rocks occur in several cm-m thick layers, parallel to the regional foliation. At places, biotite is quite abundant, forming clusters with garnet, or parallel bands with or devoid of garnet. Pyroxene-bearing granulites and amphibole-biotite-rich rocks are subordinate rock types in the areas investigated. The former one occurs in the České středohoří basement (borehole T38), both the types were newly described from Stráž nad Ohří quarry.

A special rock type occurring in minor amounts in the Ohře crystalline area represent kyanite ± garnet-bearing melts (Photo 6), which might be considered as a result of dehydration melting, and garnet-kyanite-bearing migmatitic gneisses.

Felsic granulites (Photo 1,2) are characterized by less abundant garnet and kyanite, predominance of K-feldspar over plagioclase and the general absence of micas. The rocks described as metapelitic (Photo 3) contain high garnet ± biotite (muscovite) abundances, and more plagioclase. Increasing amounts of biotite indicate the transition to granulite gneisses (cf. Kopecký & Sattran 1966), that have banded structure and reduced grain size (Photo 4). Characteristic feature of granulites is generally well-preserved high P-T mineral assemblage (in low-deformed rocks, see below). Peak mineral assemblage of the two types is garnet-kyanite-mesoperthite-quartz, that of pyroxene-bearing granulites garnet-clinopyroxene-antiperthite-quartz (Photo 5).

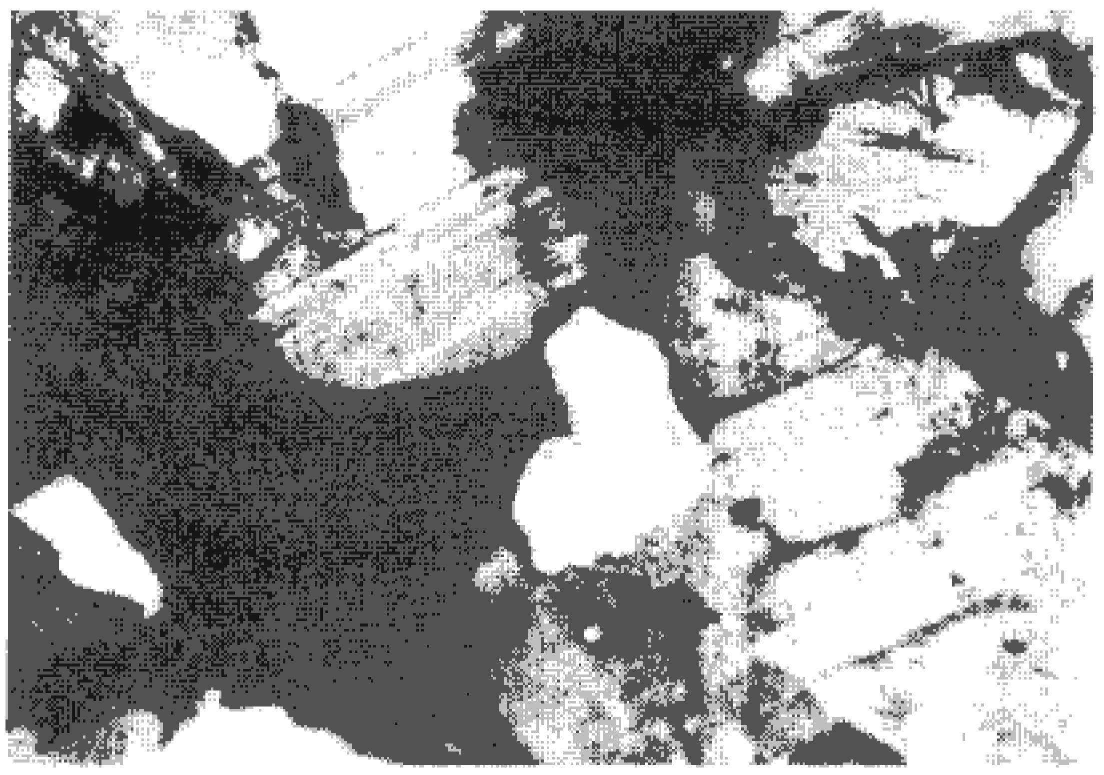

Photo 1 Felsic granulite, Stráž nad Ohří quarry; Grt II nucleating on kyanite; mult. 64x, // nicols

5.2 Deformation and paragenetic history of the granulitic rocks

Granulites are texturally heterogeneous on mesoscopic scale. Coarse-grained granulites, with only slight preferred orientation of minerals (kyanite, quartz) are juxtaposed to finer-grained granulitic gneisses (Bt ± Ms-bearing) with a strong mesoscopic planar-linear fabric (L-S tectonites). Transitions between these two rock types allow one to regard their coexistence as the result of the heterogeneity of finite strain distribution, which is a common feature in naturally deformed rocks (Ramsay & Graham 1970,