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Superimposed Fold Systems in the Altkristallin Rocks on the Southeast Margin of the Tauernfenster

With 8 Figures

By E. R. OXBURGH *)

Faltungsphasen im Altkristallin am Südostrand des Tauernfensters

Mit 8 Abbildungen

Von E. R. OXBURGH *)

Abstract

Detailed studies of fold types and measurements of S planes and B directions have been made in an area of Altkristallin rocks immediately southwest of Obervellach, Mölltal. This area lies just outside the Tauern window. It is shown that there have been three main phases of folding in the area. An episode of early isoclinal folding was followed by a period of buckle folding. Finally the area underwent gentle flexure folding and at the same time there was incipient development of a new schistosity, parallel to the axial planes of microfolds associated with the flexures. The geometry of the three groups of folds is discussed. It is shown that deformation throughout the area has been homogeneous except for that part which is nearest the edge of the Tauernfenster. This result is disscussed.

Zusammenfassung

Im Bereich des Altkristallins unmittelbar südwestlich von Obervellach im Mölltal wurden Detailstudien an Faltentypen und Gefügemessungen von S-Flächen und B-Achsen ausgeführt. Das bearbeitete Gebiet liegt knapp außerhalb des Tauernfensters. Es wird gezeigt, daß sich hier drei Hauptfaltungsphasen

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unterscheiden lassen. Einer ersten Isoklinalfaltung folgt eine Periode von „Buckelfaltung". Die letzte Deformation prägte eine sanfte Flexurfaltung bei gleichzeitiger Ausbildung neuer Schieferungsflächen parallel zu den Achsenebenen von Mikrofalten, in Zusammenhang mit der Ausbildung der Flexuren. Es konnte ferner gezeigt werden, daß die Deformation im ganzen Gebiet homogen war, mit Ausnahme jenes Anteils, welcher dem Rande des Tauernfensters am nächsten liegt. Obige Ergebnisse werden näher diskutiert.

Contents.

Introduction

During the summer of 1963, while samples were being collected on Polinik for radiometric age determination, the writer noticed striking evidence of a number of different phases of folding in the Altkristallin rocks which form the southeast side of the Tauernfenster. These rocks are thought to be of pre-Triassic age and to have been thrust northwards over the gneisses and Mesozoic metasediments of the Tauern (Exner, 1954).

The writer returned to the area in 1964 and spent about five weeks making a detailed study of the fold relationships. The purpose of the study was threefold: first to establish the nature and sequence of the folding episodes — there was the possibility that these might be sufficiently distinctive to allow the certain recognition of Altkristallin rocks within the Tauernfenster. Second, it should be possible to establish to what extent the Altkristallin rocks of Polinik had been affected by the Tertiary deformation and metamorphism of the Tauern Schieferhülle and Zentralgneis (Exner, 1954, 1962). Third, the cursory work of 1963 had suggested that during one of the deformation phases in the Altkristallin a most interesting set of conjugate folds had developed. Conjugate folding is a phenomenon which is not common and one which is poorly understood. The conjugate folds of Polinik were therefore well worth studying for their own sake.

The writer is not aware of any previous detailed work of this type in the area studied. Exner (1954) in his general study of the southeast corner of the Tauernfenster and his more detailed study of the Mölltallinie (1962 a), examined the margins of the Tauernfenster and showed that the fold axes of the Altkristallin were discordant with those of the Mölltal. Part of the area covered by Fig. 2 is shown on Exner's map of the Sonnblickgruppe (1962 b). Exner (1954; 1962 a) also gives a full account of the early investigation of this part of the Tauernfenster. HOLZER (1958) has published a photogeological map at a scale of 1 : 50,000, which includes the area mapped by the author.

Methods of Work

The location of the area studied in detail is shown in Fig. 1. The lower ground below about 1500 m is generally thickly forested and is in part mantled by glacial deposits; thus good exposures are not numerous and in some cases there is difficulty in distinguishing very large erratic blocks from bedrock outcrop. On the higher ground, however, the exosure is excellent and semicontinous.

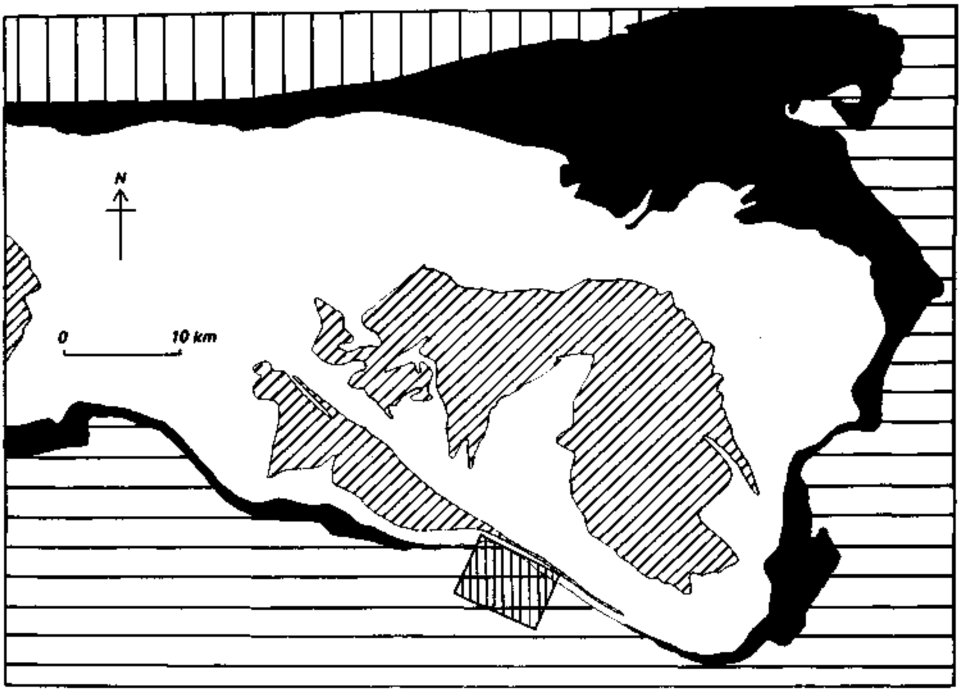

Fig. 1. Geological sketch map of the Eastern Tauern showing the position of the area studied (closely spaced vertical ruling); vertical widely spaced ruling — Grauwacke zone; black — Unterostalpin; white — Schieferhülle; oblique ruling — Zentralgneis; horizontal ruling — Oberostalpin. After EXNER (1956).

The principles upon which this study is based are largely those first described by SANDER (1948, 1950) and more recently elaborated by WEISS (1957), RAMSAY (1960, 1962 a, 1962 b) and TURNER and WEISS (1963). All the work was, however, done on the macroscopic and mesoscopic rather than the microscopic scale.

At almost every exposure there is evidence of two, three or occasionally even four, different linear features (B directions); these might include fold axes, regular rippling of S planes by microfolds, preferred orientation of inequidimensional components, etc. Planar features (S planes) measured, include attitudes of the foliation, the axial surfaces of folds, secondary schistosities and knick planes.

Measurements were made with the CLAR Gefügecompas which is the best instrument for this purpose known to the writer. In general a number (i. e. up to 10) of measurements of each type of fabric element were made at each exposure. These measurements were then plotted on an equal-area stereographic net and their mutual geometrical relationships established by the conventional techniques (TURNER & WEISS, 1963).

As may be seen in Fig. 2, observations were concentrated within two mutually intersecting elongate zones. One zone runs E—W, approximately parallel to the Mölltal; its upper side is at about 1500 m and the lower side at about 700 m. The other zone trends NE—SW, following the line of the Wunzen Alm, and makes a large angle with the Mölltal; the ground at its SW end is at 2000 m and that at the NE end about 700 m.

This arrangement was in part dictated by the availability of exposure and general accessibility, and in part designed to allow comparison of deformation patterns both at different structural levels within the Altkristallin block and along lines of different orientation through it.

In this paper several different generations of folding will be established and their mutual age relationships discussed. A detailed analysis of the fold geometry is not presented but the general geometrical relationships are discussed.

Lithologies

A detailed account of the rock types exposed within the area mapped will not be given here as a systematic petrographic study has not yet been carried out; some general observations will, however, be made.

The rocks of the Altkristallin of Polinik represent a predominantly metasedimentary series of regionally metamorphosed rocks. The grade of metamorphism is indicated by the abundant development of garnet and biotite in rocks of pelitic composition. EXNER (1962 b) also records the occurrence of staurolite but this has not yet been recognised by the writer. In addition to the definitely metasedimentary rocks there occur some gneissose rocks with large augen of microcline; these are of granitic composition. There are a few amphibolites. The main rock types recognised are listed below: —

(1) The most abundant rock type is a mesocratic biotite muscovite feldspathic schist (fig. 2). This rock carries small knots of feldspar up to 2 mm in diameter, in a coarse, micaceous matrix within which the proportions of biotite and muscovite may vary considerably. There is subsidiary quartz and garnet.

(2) Less common is a mica schist, which is poor in feldspar and rich in quartz; in this rock muscovite tends to be more abundant than biotite.

(3) There also occur mesocratic, fine grained (less than 0.5 mm) somewhat fissile, quartzo-feldspathic rocks which carry subsidiary mica as dispersed, small flakes (about 1.5 mm long) with strong preferred orientation. There is occasional accessory garnet and/or tourmaline.

(4) Showing almost all gradations into type (3) there are coarse, microcline augengneisses. These are mesocratic rocks of variable grain size, but the augen may reach 2 cm in diameter. The mica content is variable but rarely exceeds 5%; quartz and feldspar are the only important constituents.

(5) At a number of localities, bands (10 cm—2 m) of calcite marble occur. These weather to a yellow-brown colour but fresh surfaces are nearly white. The

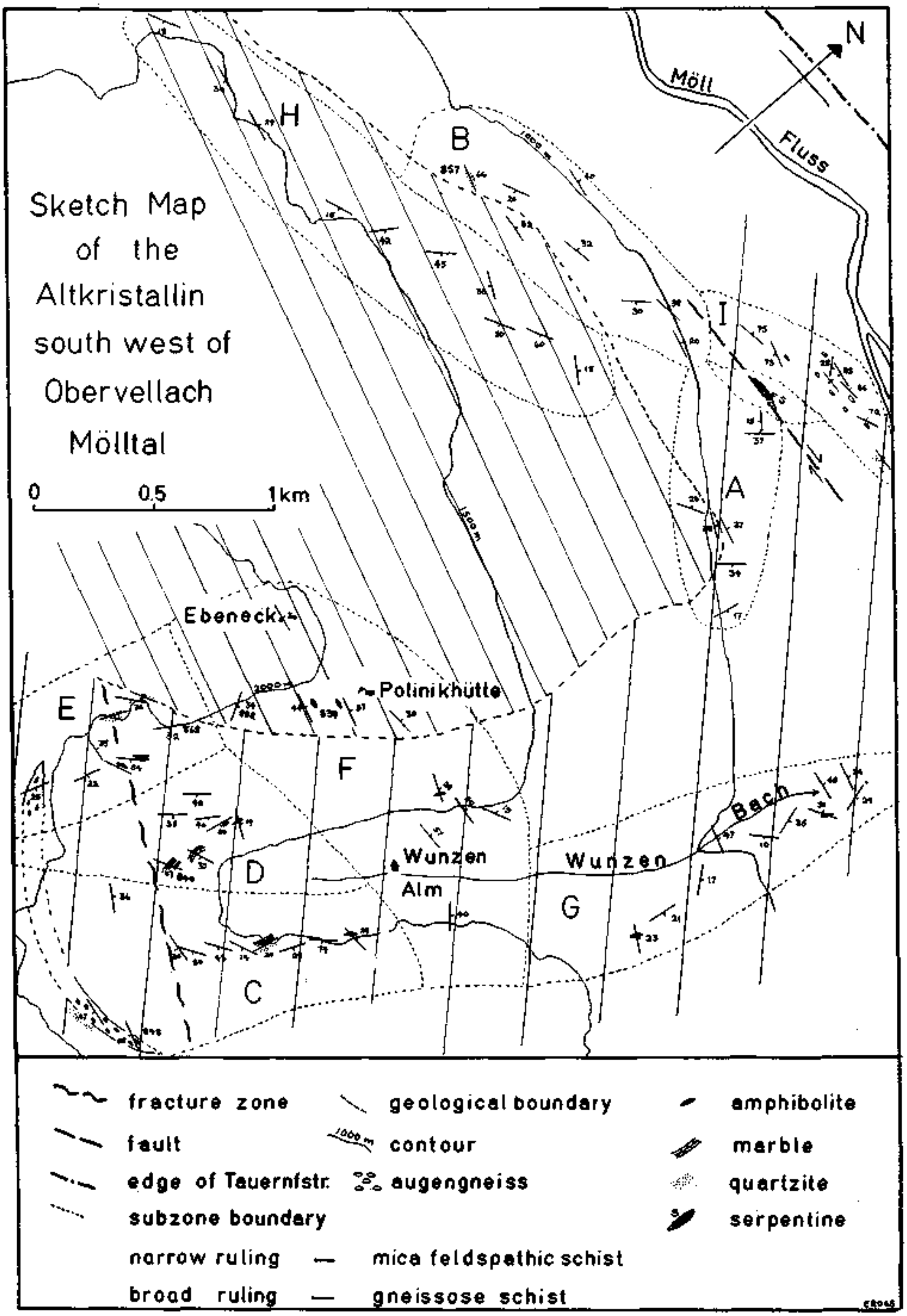

Fig. 2. Geological sketch map of the Altkristallin southwest of Obervellach, Mölltal. A representative sample of the measured attitudes of S has been plotted. "Mica feldspathic schist" is described under rock type (1) in the text; "gneissose schist" is described under rock types (2) and (3) in the text. Large capital letters are used to designate the various sub-areas.

average grain size is about 0.5 mm. The marbles appear to be fairly pure and the only other component observed is subsidiary muscovite.

(6) Locally there are thin bands of quartzite (10—30 cm). Both light coloured, and nearly black varieties are found. Their grain size is about 0.5 mm and they have no obvious impurities.

(7) In a few places amphibolites occur. They generally form discontinuous pods within schistose rocks. The pods rarely exceed 50 cm in their maximum dimension. In nearly every case the amphibolites show the development of biotite round their margins.

(8) At one locality along a fault zone, dark green, strongly sheared serpentinite occurs.

The small amount of thin section petrography which has been done on these rocks reveals one important characteristic not apparent from field observation. All thin sections examined show extreme textural disequilibrium; quartz and feldspar boundaries are extremely denticulate and intergrown, indicating that the individual grains have a very high ratio of surface area to volume. In addition, in almost every case, the micas are seen to be strongly deformed; severely bent cleavages are common and in some cases crystals have been torn apart. Interpreted together, the texture and deformed mica suggest an episode of strong penetrative movements which occurred later than the main metamorphic recrystallization. This episode caused granulation of the feldspar and quartz and deformation of the micas. Subsequently it was possible for the granulated quartz and feldspar to partially recrystallize to give the present disequilibrium texture. The recrystallization did not, however, extend to the muscovite.

These textural features are in striking contrast to those found within the Tauern window in the Schieferhülle and Zentralgneis on the other side of the Mölltal.

Description of Fold Styles

Three main styles of fold are developed within the Altkristallin. These are believed to represent three separate episodes in the deformational history of the area. The mutual relationships of these fold styles will be discussed after each has been described.

(1) Isoclinal folding: There are at least two kinds of isoclinal fold within the area; one of these, however, which is evidently related to the buckles described in the next section will be discussed below. The isoclines to be discussed here are generally not very conspicuous features. Typical is that recorded at station 848 at the head of the Wunzen Alm. As shown in Fig. 3 a, the fold is defined by a layer of biotite schist about 30 cm thick which is folded back on itself to define a sharp fold hinge. Within the schist band there is a core of muscovitic quartzite. The axial plane of the isocline is nearly horizontal and parallel to the foliation of the surrounding augengneiss. A metre or so away from the hinge of the fold, S attitudes both inside and outside the structure are parallel and give no indication of the nature of the deformation. In this case, however, the compositions of the rocks involved would demonstrate the existence of folding. On the other hand, in other examples examined where the lithological contrast was, say, between marble and schist, had not the hinge of the marble isocline within the schist been exposed, the sequence could reasonably have been interpreted as two successive and different marble bands within a schist unit. Equally,

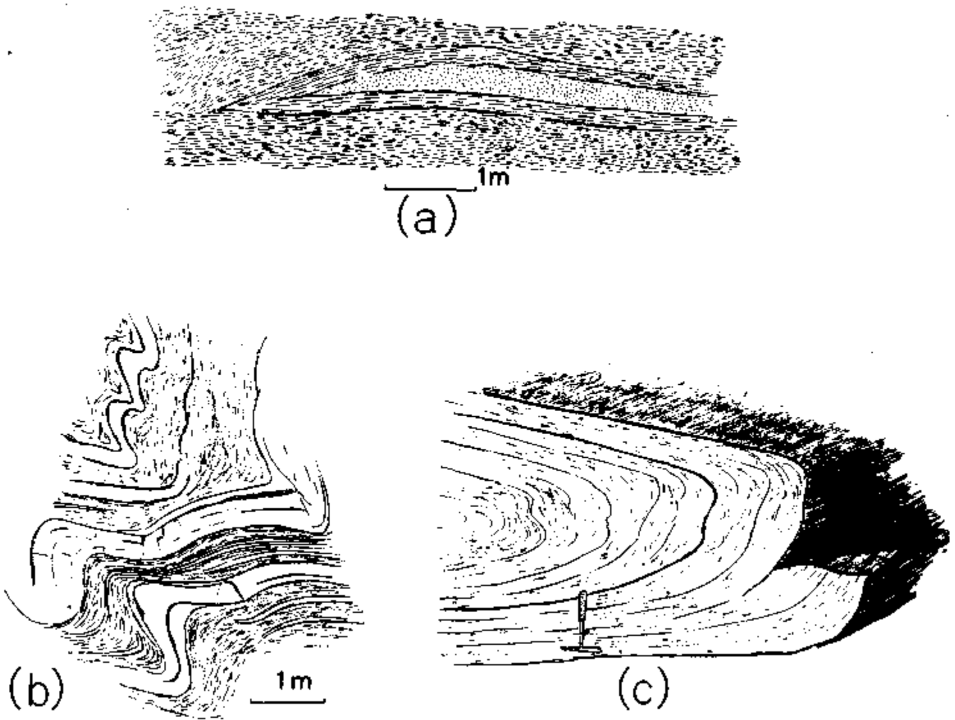

Fig. 3. (a) F_1 isocline of metasedimentary rocks in augen gneiss (see text). (b) F_2 buckles in quartzofeldspathic schist intercalated with mica schist (see text; drawn from a photograph). (c) A flattened F_2 buckle (see text; drawn from a photograph).

a short distance from the marble isocline there is no indication of the folding in the schist although it must have taken part in the same deformation.

The wavelength of the isocline shown in Fig. 3 a is about 1 m and the amplitude is greater than 20 m. These proportions are typical of this group of folds. The fold hinges are characteristically rather sharp and the fold axes rather variable in orientation.

Thus, although obvious examples of this type of fold are not numerous, these folds may be much more abundant than they seem because circumstances may commonly combine to prevent their recognition. To establish their presence it is necessary (1) that there be some lithological contrast within the folded rocks and (2) that either the fold hinge be exposed or the sequence of concordant lithologies be such that it could only have originated through tectonic activity, e. g. a marble layer both underlain and overlain by augengneiss.

(2) Buckles: The folds included under this name are the most striking and possibly the most abundantly exposed type in the area. Three examples will be described in some detail. The first occurs at station 868 on the path from the head of the Wunzen Alm to the Polinikhütte. Bands of quartzitic schist ranging from 10 cm to 1 m in thickness are separated by 10—30 cm bands of more micaceous schist and define a series of overturned, assymetrical buckle folds (fig. 3 b). The deformation has been controlled by the quartzitic bands which appear to have undergone external rotation accompanied by a combination of

concentric shear and inhomogeneous pure shear. There is no macroscopic axial plane schistosity in the quartzitic layers. There is generally relatively little difference in thickness between the steep, short limbs and the fold crests but, by comparison with these, the more gently dipping, longer limbs are rather attenuated; their thickness measured normal to the bedding may be less than half that of the steep limbs. There is considerable variation in the amplitude and wavelength of these folds; at this exposure the largest wavelength was 2 m and the greatest amplitude 1 m.

Elsewhere the buckles are much more tightly appressed and may occur on a much larger scale. In this form the buckles are commonly recumbent and isoclinal but are different from the isoclines of the previous section; their amplitude/wavelength ratio is much less and their hinges are broad and rounded (fig. 3 c), in marked contrast to the sharp, angular hinges of the other group. In some cases the relative thinning of the limbs with respect to the hinge is extreme; even in micaceous quartzites the thickness (measured at right angles to the schistosity) on the limbs may be less than 1/5 that at the hinge. Thus, in addition to the external rotation, these folds have been considerably flattened. Folds of this style with an amplitude of 4 m and a wavelength of 1.5 m are common and in several places these values reach 20 m and 7 m respectively.

The most remarkable feature of the buckle folds, however, is their occurrence as conjugate folds. Generally this is not apparent from a single outcrop and the main effect is observed between closely spaced outcrops as a rather rapid alternation in the attitudes of the axial surfaces of the buckles, from a shallow dip in one direction to a shallow dip in the other. In one exposure (stn. 852), however, on the path between the Polinikhütte and the Steinbühlhütte, this alternation is seen several times within a few metres of continuous exposure (fig. 4). Here the folds are defined by micaceous quartzite bands in a feldspathic schist and are of rather small scale (wavelength ~ 50 cm, amplitude ~ 20 cm). There is an angle of about 50° between the axial planes of the folds which face east and those which face west. The axes of the east and west facing folds are parallel within the limits of accuracy of measurement and natural variation; their styles are similar and they are of similar amplitude. There seems to be little doubt that the

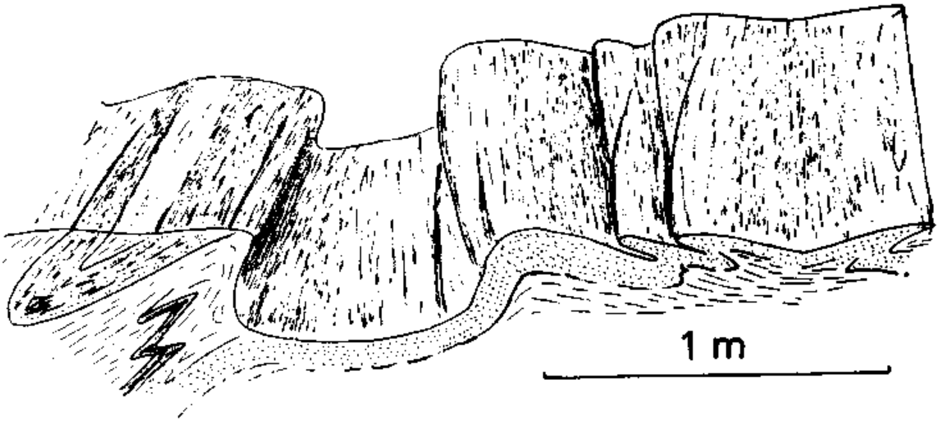

Fig. 4. Conjugate F_2 buckles. The axial planes of the buckles are seen to alternate rapidly in their direction of inclination. Note the en echelon arrangement of the folds in the left hand side of the figure. Drawn from a photograph.

east and the west facing folds are conjugate and were formed in the same phase of deformation.

Two other features of this exposure are of particular interest. Some of the minor folds in the thinner bands of micaceous quartzite (0.5—1 cm), although of smaller amplitude, have proportions similar to those of the larger folds and have parallel axes and axial planes. They are, however, more tightly appressed and almost isoclinal. They may be distinguished from the isoclines described in the previous section by their much smaller amplitude/wavelength ratio. Similar, small isoclinal folds are found throughout the area studied; they commonly occur within masses of homogeneous mica schist and are defined by lenticular quartz segregations, 0.5—1.5 cm thick and 10—20 cm long (fig. 5 a); the folds thus appear "rootless" in the form of the letter Z or S. Because of their similarity to the larger scale buckles in orientation of axes and axial planes, these abundant quartz isoclines are interpreted as related to the buckle folds rather than the early isoclines described above.

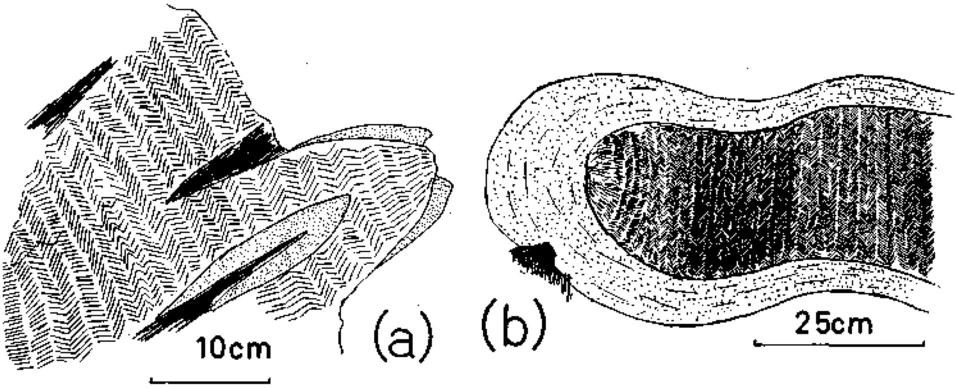

Fig. 5. (a) A small isocline of F_2 age formed by a quartz vein (dotted) in core of an F_2 buckle in mica schist (hatched). A second quartz vein, partly eroded, is obviously buckled. Drawn from a photograph. (b) A recumbent F_2 buckle with a nearly horizontal axial surface is flexured by F_3 folds. The dotted layer is quartzose while the material within it is micaceous and schistose; the hatching shows schematically the incipient development of a new, near vertical schistosity parallel to the axial planes of the microfolds in the schist. This exposure establishes the age relations of the flexures and the buckles (see text).

A further feature of interest at station 852 is the variation in orientation of the fold axis within a single fold. The variation is entirely within the axial plane of the fold, but within this plane there is a fluctuation of up to 15° in either direction about the mean. In several places in this exposure the appressed buckles have an enechelon relationship to each other; as one fold is superceded by another, its axis swings sharply from the mean direction and rapidly peters out (fig. 4).

Associated with all the types of buckle described in this section there is a penetrative microfold lineation parallel to the buckle axes. This lineation is developed on nearly every schistosity plane as a small undulation with amplitude and wavelength both of the order of 1 mm. The prominence of its development, however, varies somewhat with the lithology.

(3) Flexures: The third and last main group of folds recognised in the area is characterized by flexuring. The folds are gentle and open, and have formed by slight external rotation; wavelength may vary from 10 cm to 2 m but the amplitude/wavelength ratio rarely exceeds $^1/_5$ (fig. 5 b). This style of deformation, however, is restricted to the competent quartzose or quartzo-feldspathic bands. In the incompetent mica schists within which the competent bands occur, the expression of this episode of deformation is quite different. There is intense crenulation of the schistosity planes into sharp crested, straight limbed, symmetrical or asymmetrical microfolds (wavelength and amplitude ~ 0.5 cm). The microfolds in adjacent schistosity layers rest closely one upon the other with planar axial surfaces which are generally within 20° of vertical. The axes of the sharp microfolds are parallel to those of the broad, gentle flexures in the competent layers. In places the microfolds are so strongly developed that a new schistosity has formed parallel to their axial planes; locally this has become the principal planar feature of the outcrop and the previous schistosity, parallel to the axial surfaces of the old isoclines, is almost obliterated. This new schistosity is extremely variable in the intensity of its development.

Other Structural Elements

In addition to the groups of folds described above there is a widespread development of both knick planes and joint planes. No special study has been made of these features and they appear to represent a rather later phase in the deformational history of the area.

The knick planes commonly occur in conjugate pairs with opposite senses of displacement; they have been observed locally to pass into shear joints. Both tension joints and conjugate sets of shear joints are developed.

Age Relations of the Fold Types

The writer has so far attempted to show that there are three main groups of fold features represented in the area studied. Each group is characterized by its

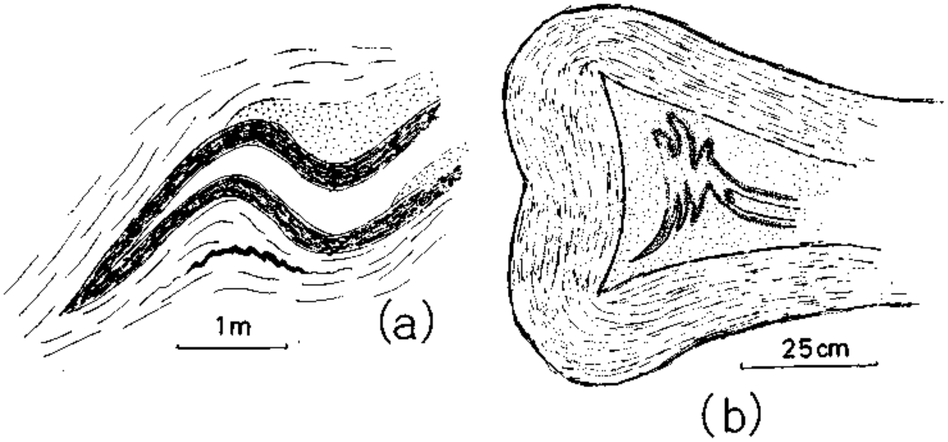

Fig. 6. (a) An F_1 isocline folded by an F_2 buckle. This exposure establishes the age relations between these two phases of folding (see text). Dark shading — amphibolite; dotted shading — pegmatite; white — quartzo feldspathic schist; black — quartz vein; dashed — marble. (b) A tightly crumpled F_1 isocline in the core of an F_2 buckle. (Drawn from a photograph.)

own style of deformation and to a lesser extent its own scale. The geometrical relationships of fabric elements within each group and between the groups are discussed later. Here the age relationship between the groups is established.

At a number of exposures the relationship between the isoclines and the buckles is clearly demonstrated. At station 840, at the head of the Wunzen Alm, an amphibolite layer is folded back on itself to define a tight isocline with a quartzo-feldspathic core; the amphibolite is surrounded by a medium grained, brown weathering marble. As shown in fig. 6 a, the isocline has subsequently been buckled; the quartz vein parallel to the lower limb of the isocline is buckled but not isoclinally folded and so was presumably formed after the phase of isoclinal folding. Comparable situations are found in several other places. Although not typical, the same relationship is seen in the core of a large, tight, recumbent buckle at station 839 above the path between the Polinikhütte and the Steinbühlhütte. The intense crumpling of the isocline within the buckle core is shown in fig. 6 b. Therefore, because isoclines are themselves deformed by buckling and because the converse situation is nowhere found, it is concluded that the phase of isoclinal folding occurred earlier than the phase of buckle folding.

The relationship between the buckles and flexures may be established at a number of different localities. Typical is that at station 857 where a recumbent buckle of feldspathic, micaceous quartzite with intercalated schistose layers is itself flexured (fig. 5 b); the quartzite is gently flexured while the schistose layers are tightly crinkled with the incipient development of a new axial plane schistosity at a high angle to the earlier one. Thus the phase of buckling occurred earlier than the phase of flexuring.

Three groups of folds are therefore established and a time sequence for their formation is proposed.

(1) Isoclines — oldest folds recognised in the area: from here on designated "F_1 folds".

(2) Buckles — younger than F_1 folds: from here on designated "F_2 folds".

(3) Flexures etc. — younger than both F_2 and F_1 folds: from here on designated "F_3 folds".

Comments on the Geometry of the Folding

Although the main purpose of this paper is to demonstrate the sequence of fold development within the area examined, a few preliminary comments will be made on the geometry of the fold systems.

Geometry of B. The term B is used to signify fold axes and any other penetrative linear feature which may be measured directly. The axes of the F_1 isoclines are extremely variable and may have almost any orientation within S. This is not unusual behaviour for early isoclinal folds and may result at least in part from differential flattening (Ramsay, 1962 b) normal to S during the formation of the isoclines (fig. 7). F_1 lineations, although probably widely developed, cannot be definitely recognised as such away from the noses of the isoclines. The F_2 buckle axes exercise the controlling influence on the attitude of S throughout the area, and about these the axial surfaces of the F_1 folds are deformed. Because the F_3 folds are of much smaller amplitude than those developed about F_2 axes, they do not greatly disturb the pattern of distribution of S attitudes determined by F_2.

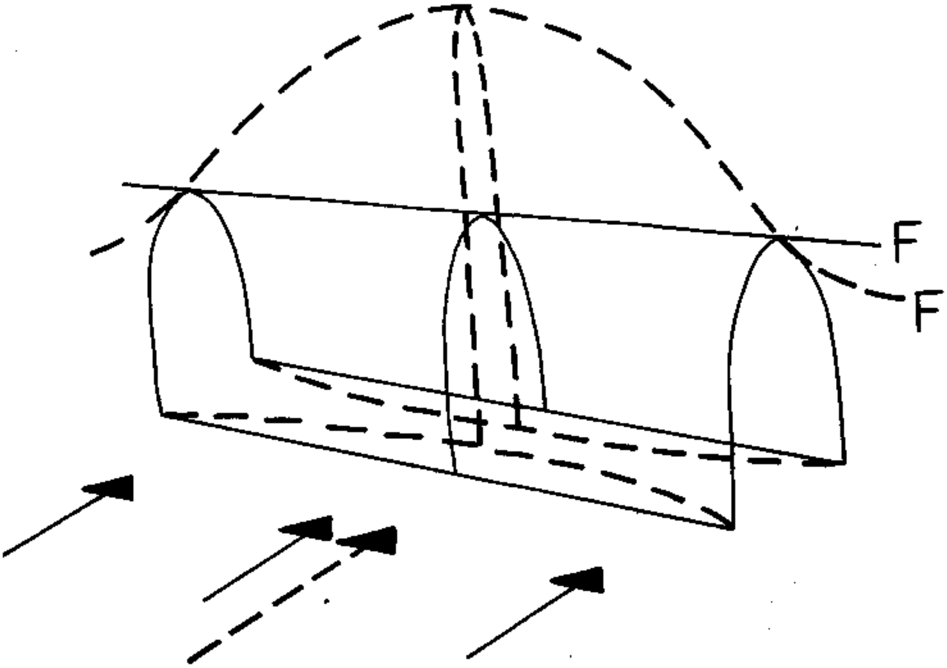

Fig. 7. Sketch to show how differential flattening of an isocline may produce variation in orientation of the fold axis (F_1). Had the flattening been uniform, the axis would have been more nearly rectilinear (F). (After Ramsey, 1962 a.)

F_3 axes are found to be nearly parallel to F_2 axes and there are few situations in which the angle between them is greater than 30°. There is commonly, however, a large difference between the attitudes of their axial surfaces (fig. 5 b). When the linear features and fold axes associated with both F_2 and F_3 are plotted on a stereogram, the features of the two generations do not form distinct groups. Rather they form coincident, diffuse groups distributed along the northeast sectors of two intersecting great circles with strikes N10E and N75W and dips of 25° E and 35° N respectively.

The significance of these two great circles is probably that they represent the two conjugate axial plane directions associated with development of the F_2 buckles. The two planes intersect at a solid angle of about 40°. Detailed discussion of these relationships must be deferred until further field work is completed.

Geometry of S. On fig. 2 are plotted a few selected attitudes of S in order to give some impression of the general behaviour of the foliation within the area. For the purposes of analysis the area was broken down into 26 sectors; it was later possible to recombine these into 9 sub-areas. The boundaries of the sub-areas are shown on fig. 2. Initially all π-poles (normals to S) were plotted for each sector on equal area stereograms. In those cases where two or more adjoining sectors showed similar π-pole distribution, the sectors were combined into sub-areas and a π-pole diagram for each sub-area produced. By constructing the normal to the great circle defined by the π-poles for each sub-area, β was derived for each

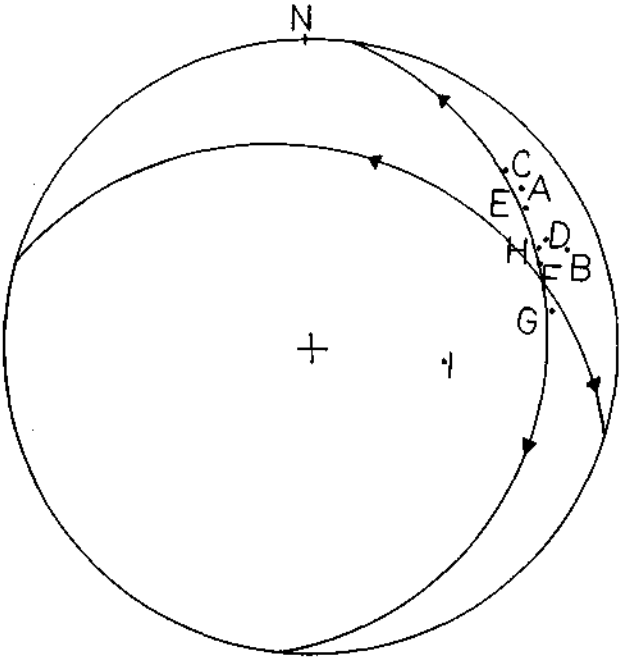

Fig. 8. Equal area, lower hemisphere, stereographic projection of β for each of the sub-areas indicated in Fig. 2; the point for each sub-area is designated by the appropriate letter (see Fig. 2). The two great circles represent the loci of the F_3 and F_2 lineations and fold axes, the majority of which lie in the northeast sector between the black arrow heads (see text for discussion).

sub-area. Established in this way β is the controlling fold axis for the sub-area for which it is determined (WEISS and MCINTYRE, 1957).

Figure 8 shows the range of positions of β in the different sub-areas. It will be noted that β for sub-area I falls some distance from the main group of β positions. Sub-area I is on the extreme margin of Altkristallin rocks and just outside the window and therefore possibly nearest the base of the Oberostalpin thrust sheet; in the field the zone is seen to be severely sheared. It appears then that either the northward movement of the Oberostalpin thrust sheet (of which the Polinik Altkristallin is a part) or the late vertical movements along the line of the Mölltal, or both, have modified the attitudes of the marginal Altkristallin rocks.

It will be noted from fig. 8 that although the β positions from the remaining sub-areas show a considerable spread, they all lie on the same great circle and that this great circle is one of those defined by the range of B directions from F_2 and F_3 folds. It is evident also that along this great circle β fluctuates considerably from sub-area to sub-area and that there is no systematic trend in the variation over the area as a whole.

Discussion and Conclusions

It appears that the area described has undergone three main episodes of folding. There is little positive evidence as to the original orientation of the F_1 isocline axes which may in any case have been variable. Superimposed upon these were the

F_2 and F_3 folds in that order; although having similarly oriented axes, these folds were of different styles and had differently oriented axial surfaces.

On the basis of the microscopic textural relationships it appears that metamorphic recrystallization was complete, at the latest, before F_3 folding and possibly before the F_2 folding. Subsequently a partial recrystallization took place which was not, however, sufficiently intense to affect the micas. This recrystallization may have been associated with the Tauern metamorphism because even the sheared rocks of sub-area I at the edge of the sheet appear to show its effects. Thus the recrystallization probably occurred later than the Mölltal movements.

It is most interesting that except for the marginal sub-area I the area examined appears to be quite homogeneous with respect to the pattern of deformation. This appears to indicate either that Mölltal disturbance affected only the marginal sub-area, or less probably, that it affected the whole of the area uniformly and that the marginal sheared zone dates from the time of northward movement of the thrust sheet. The former interpretation would imply a sharp and localised shearing off of the Altkristallin sheet during the differential upward movement of the Tauern rocks on the other side of the Möll, rather than a broader warping of the thrust sheet along the line of differential vertical movements in the basement.

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