PROFILES THROUGH PARTS OF THE PORTJENGRAT ZONE, THE FURGG ZONE, THE ANTRONA SYNCLINE AND THE CAMUGHERA-MONCUCCO COMPLEX

The structures are viewed in the direction of plunge of the F_2 folds. Exceptions are the area marked B, where the F_2 folds are plunging towards the observer and the profiles through the Moncucco zone, viewed in the direction of plunge of the F_3 folds

Scale 1:25,000

J.A.Klein

0 1 2 3 km

Drawn by B.G.Henning

Inset 1

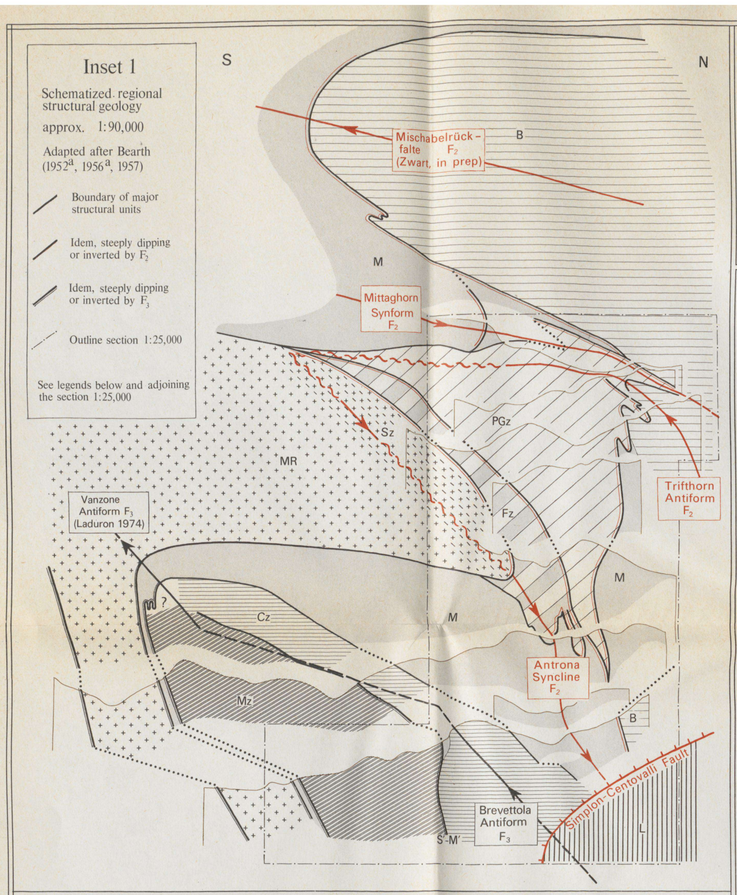
Schematized regional structural geology

approx. 1:90,000

Adapted after Bearth (1952[a], 1956[a], 1957)

- Boundary of major structural units
- Idem, steeply dipping or inverted by F_2
- Idem, steeply dipping or inverted by F_3
- Outline section 1:25,000

See legends below and adjoining the section 1:25,000



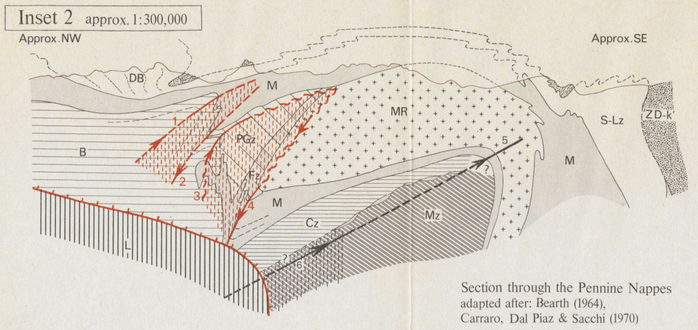
Legend Insets 1 and 2

- M — Mesozoic rocks
- ZD-k — 'Zona Diorito-kinzigitica' (Ivrea Verbanozone)
- S-Lz — Sesia-Lanzo zone
- DB — Dent Blanche Nappe
- MR — Monte Rosa Nappe s.s.
- PGz — Portjengrat zone
- Fz — Furgg zone
- Sz — Stelli zone
- B — Bernhard Nappe
- Cz — Camughera zone
- Mz — Moncucco zone
- L — Lepontine Nappes
- S-'M' — Salarioli-'Mulde'

1 Mischabelrückfalte, F_2 (Zwart, in prep)
2 Mittaghorn Synform F_2
3 Trifthorn Antiform F_3 (=Balmahornrückfalte?)
4 Antrona Syncline, F_2 (Argand 1911, Blumenthal 1952)
5 Vanzone Antiform, F_3 (Laduron 1974)
6 Brevettola Antiform, F_3

- Rocks inverted by F_2 (relative to upper limb Mischabelrückfalte)
- Rocks inverted by F_3 (relative to southern limb Antrona Syncline)

Inset 2 approx. 1:300,000



Section through the Pennine Nappes adapted after: Bearth (1964), Carraro, Dal Piaz & Sacchi (1970)

This section is schematical and not in one plane. It is oblique to the axial plane of the Vanzone-Brevettola Antiform (5-6) which therefore has a shallower dip than in reality. For explanation of letters and signs see legends above and adjoining the section 1:25,000

LEGEND

Sedimentary and igneous rocks of Mesozoic age, including quartzitic rocks of Permotriassic age, subjected to Alpine metamorphism only

- a Metasediments a) carbonaceous, b) quartzitic, differentiated in Mittaghorn area only
- Mafic igneous rocks and their metamorphic equivalents
- Serpentinites
- Z-SF Ophiolite zone of Zermatt—Saas Fee
- AN Antrona amphibolites and associated rocks
- S-'M' Metasediments of the Salarioli-'Mulde'

Furgg zone

Zone of strong early Alpine deformation, consisting of sedimentary and igneous rocks of Paleozoic age interlayered with Mesozoic sediments and igneous rocks, all subjected to Alpine metamorphism (see Wetzel 1972). Only partially differentiated here.

Metamorphic and igneous rocks of Paleozoic age or older, all subjected to Alpine metamorphism

- Orthogneisses, composition variable between aplitic and granodioritic
- Paragneisses and schists
- Paragneisses and schists, intercalated with amphibolites
- Individual amphibolite bodies
- Ultramafic body of Monteschenio
- ASF Augengneiss of Saas Fee
- B Bernhard Nappe
- PGz Portjengrat zone
- MR Monte Rosa Nappe s.s.
- Cz Camughera zone
- Mz Moncucco zone
- ML Monte Leone Nappe

STRUCTURAL SYMBOLS

- S_1 and contacts between rock units, a) observed, b) inferred
- Boundary of major structural units, a) observed, b) inferred and connection between sections
- Measured S_1 plane
- Measured S_2 plane
- S_2 mesoscopic crenulation cleavage and angle with S_1 (Shear S_2 in Saas area, see 3.4.1.
- Axial plane of F_1 fold
- Axial plane F_2 fold, a) observed, b) inferred, c) likely but not investigated
- Axial plane of F_3 fold, a) observed, b) inferred
- a) Antiform, b) synform
- F_1 mesoscopic fold, true asymmetry indicated
- F_2 mesoscopic fold, true asymmetry indicated, with measured axial plane
- F_2 mesoscopic fold, true asymmetry indicated, axial plane not measured
- F_2 mesoscopic fold, true asymmetry indicated, with measured enveloping surface and axial plane
- F_3 mesoscopic fold, true asymmetry indicated, with measured axial plane
- F_3' mesoscopic fold, true asymmetry indicated, with measured axial plane

(not to scale)

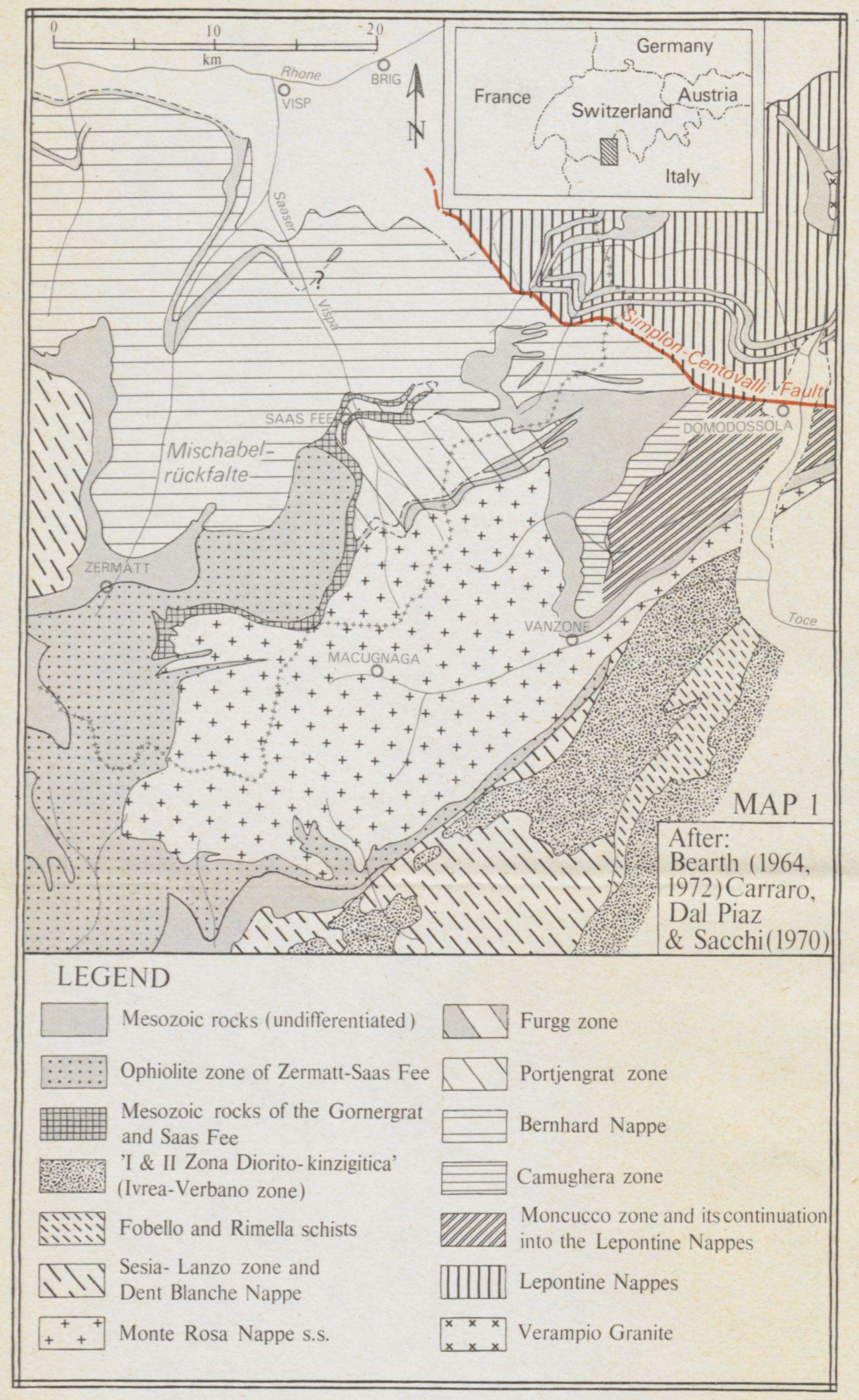
- Formline outline of folded S_1, a) observed, b) inferred
- Axial plane of F_3 fold dipping towards the observer
- Break in section
- 1–34 Numbers of folds: red-F_2, black-F_1, F_3
- Fault

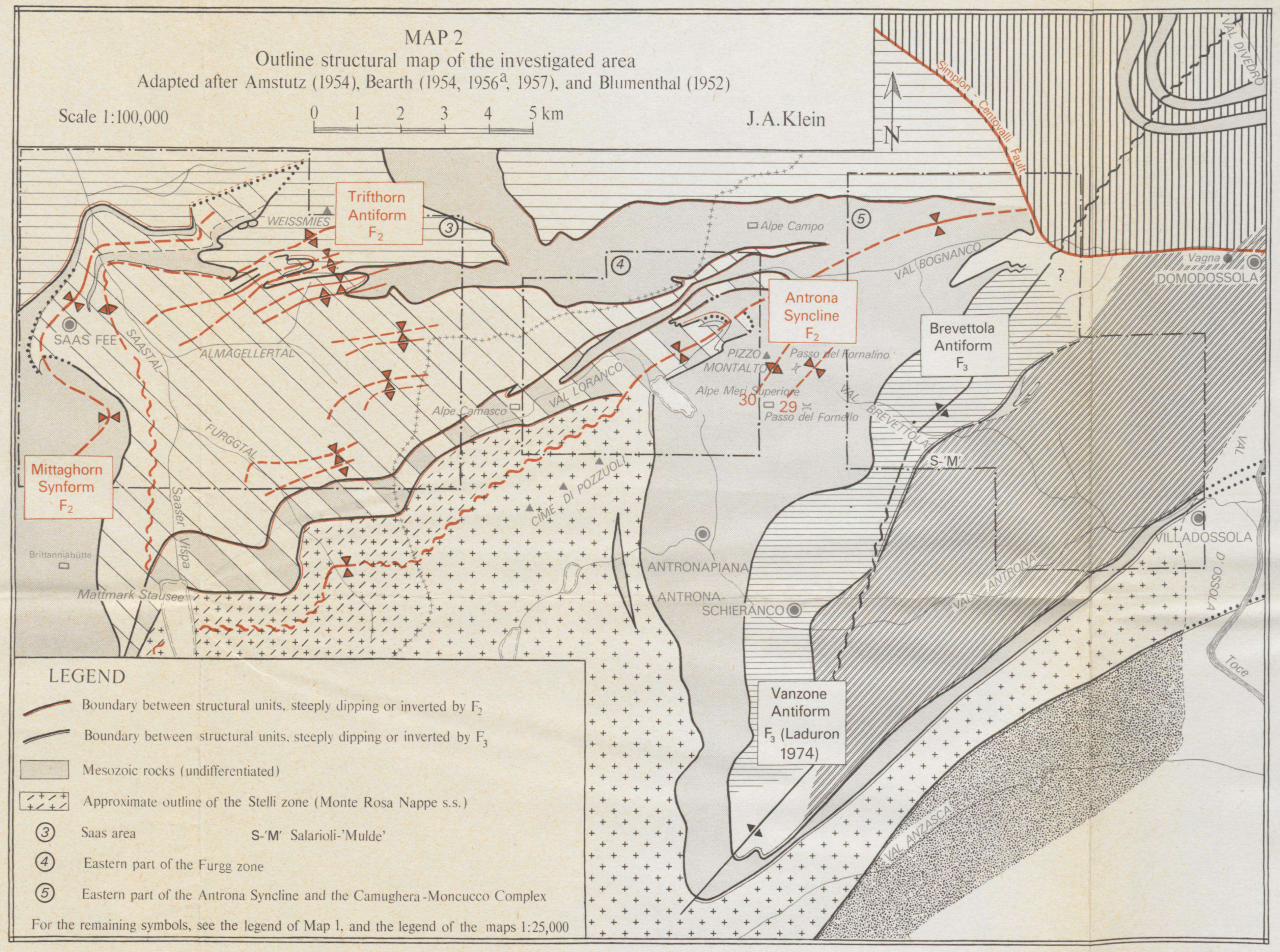
A Distorted area on section, N—S directions shortened due to divergence of the F_2 fold axes from the direction of sight

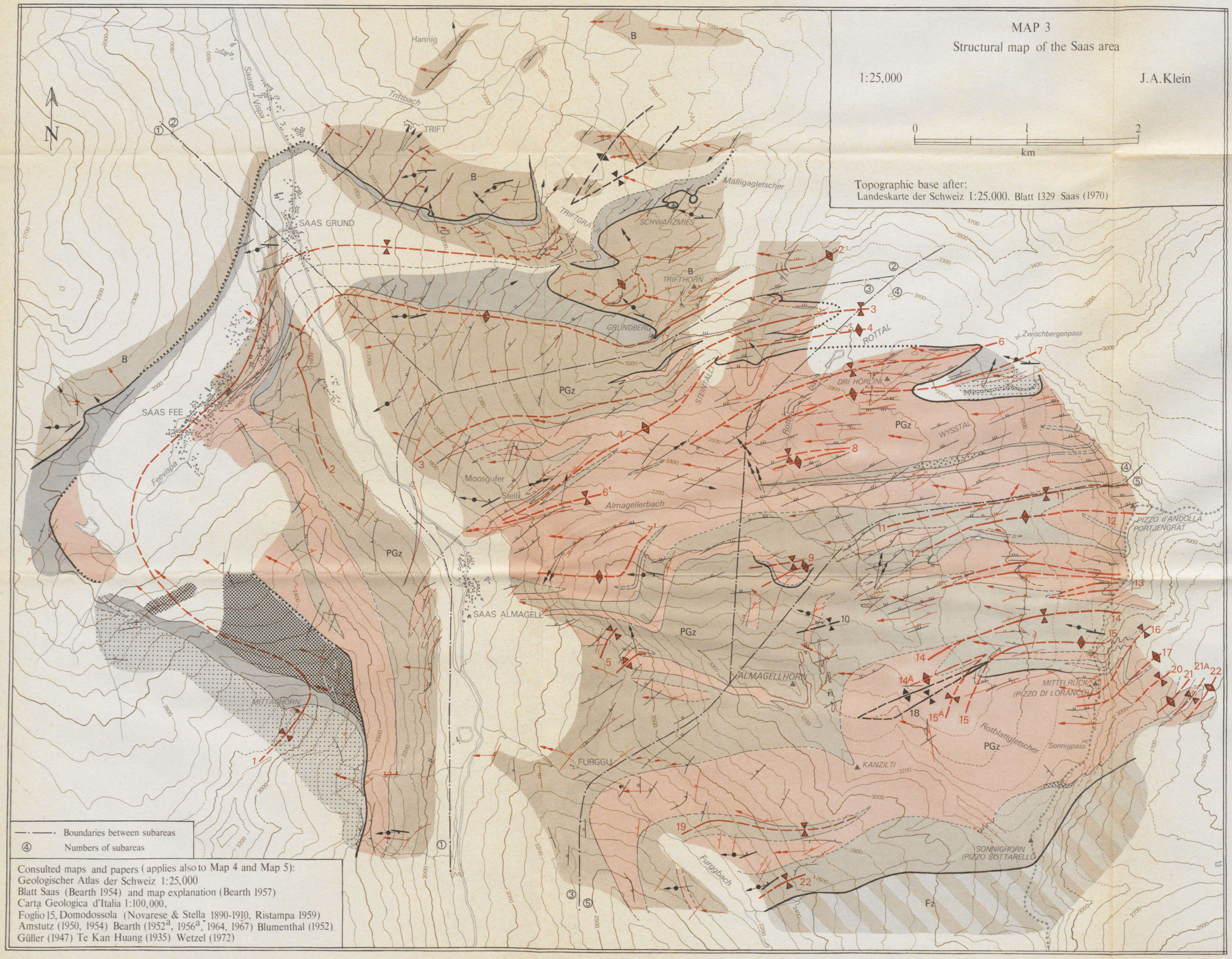
B Distorted area on section, E and W reversed, caused by easterly plunging F_2 fold axes

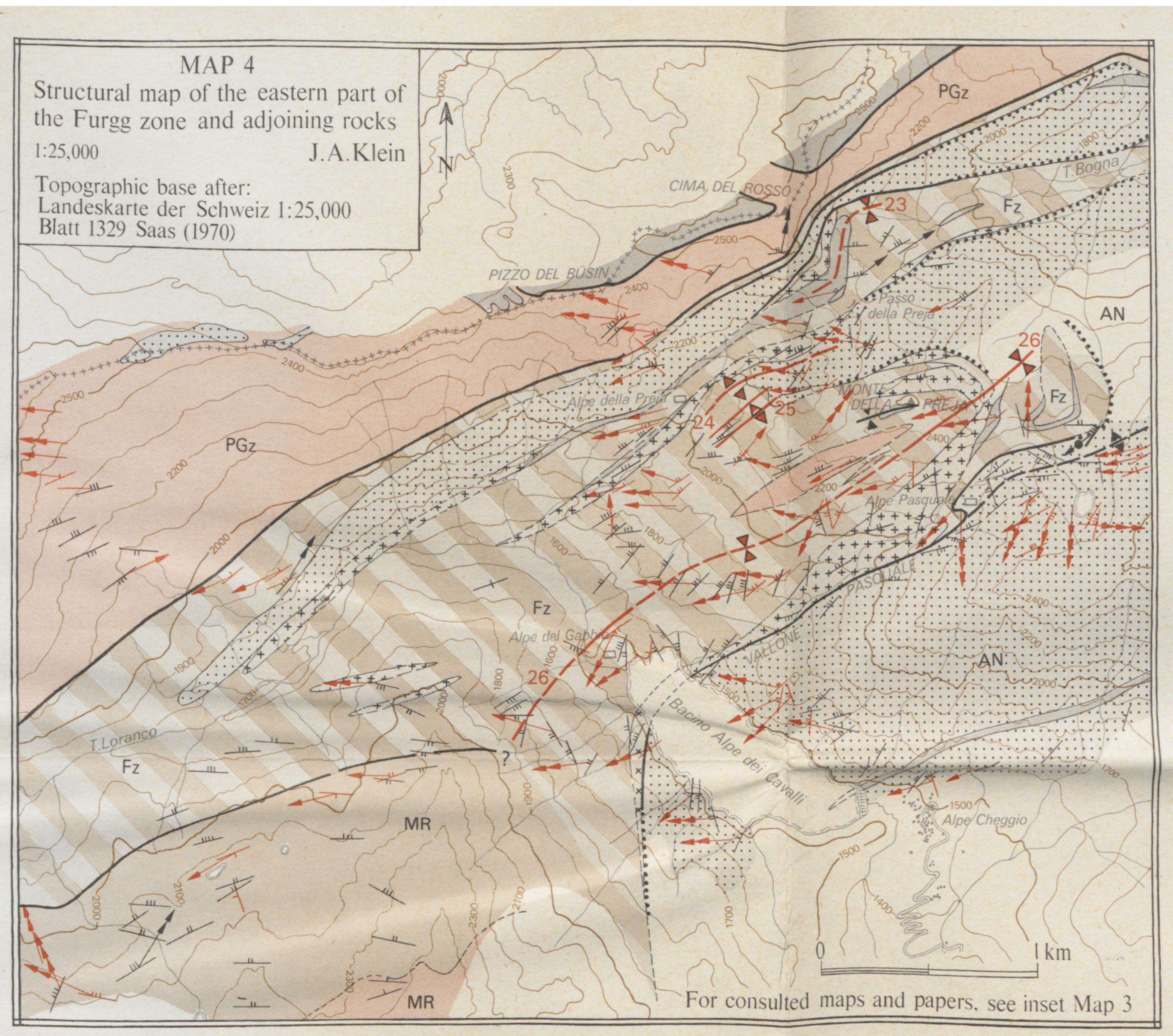
Maps and papers consulted:

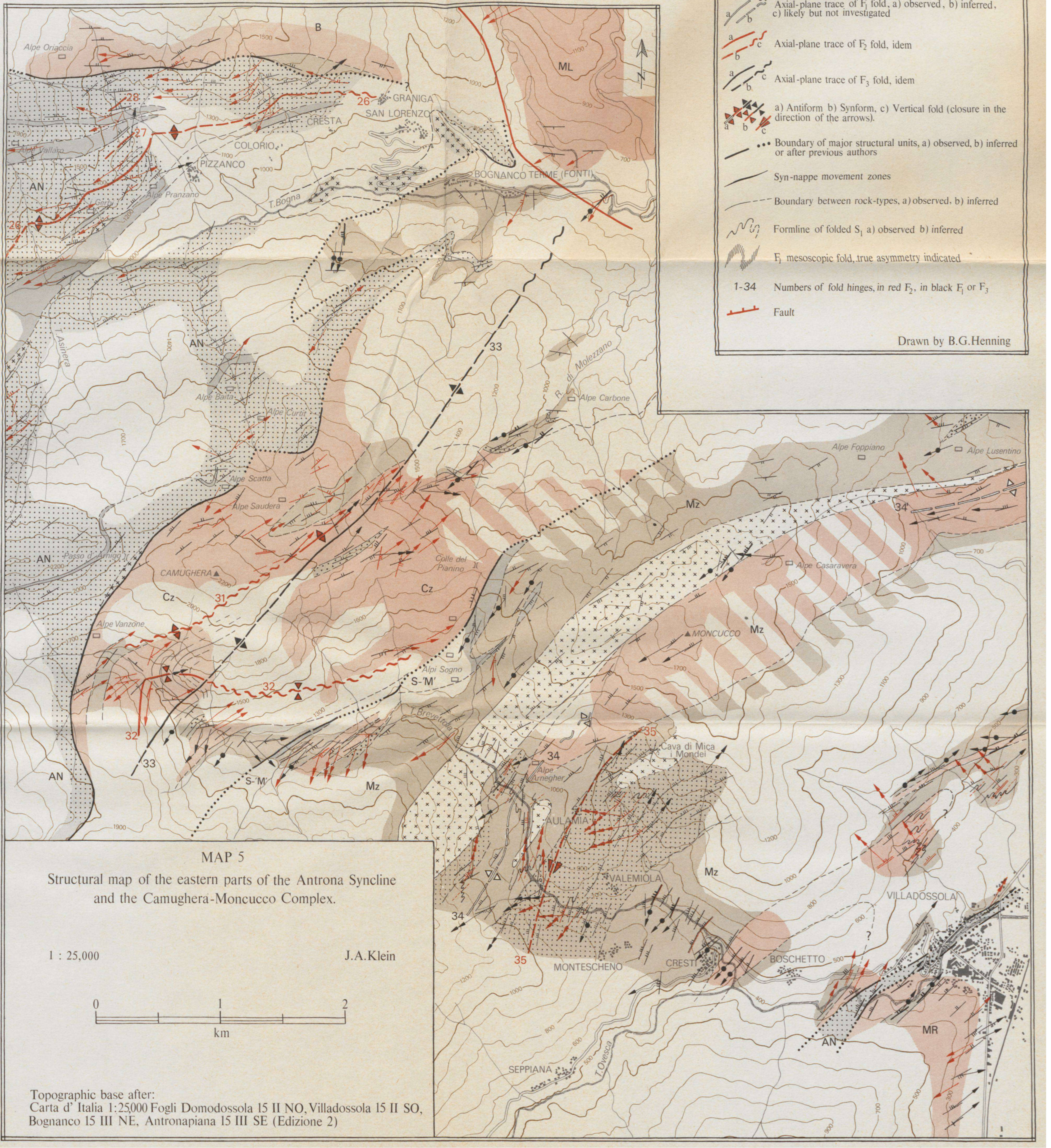
Geologischer Atlas der Schweiz 1:25,000, Blatt Saas (P.Bearth 1954) and map explanation (P. Bearth 1957).
Carta Geologica d'Italia 1:100.000, Foglio 15 Domodossola (Novarese & Stella 1890- 1910, Ristampa 1959)
Amstutz (1950, 1954); Bearth (1952[a], 1956[a], 1964, 1967); Blumenthal (1952); Te Kan Huang (1935); Wetzel (1972).


MAP 1
After:
Bearth (1964, 1972) Carraro, Dal Piaz & Sacchi (1970)
LEGEND
Mesozoic rocks (undifferentiated)
Ophiolite zone of Zermatt-Saas Fee
Mesozoic rocks of the Gornergrat and Saas Fee
'I & II Zona Diorito-kinzigitica' (Ivrea-Verbano zone)
Fobello and Rimella schists
Sesia- Lanzo zone and Dent Blanche Nappe
Monte Rosa Nappe s.s.
Furgg zone
Portjengrat zone
Bernhard Nappe
Camughera zone
Moncucco zone and its continuation into the Lepontine Nappes
Lepontine Nappes
Verampio Granite


MAP 2
Outline structural map of the investigated area
Adapted after Amstutz (1954), Bearth (1954, 1956a, 1957), and Blumenthal (1952)
Scale 1:100,000
0 1 2 3 4 5 km
J.A.Klein
Trifthorn Antiform F2
Antrona Syncline F2
Brevettola Antiform F3
Mittaghorn Synform F2
Vanzone Antiform F3 (Laduron 1974)
LEGEND
Boundary between structural units, steeply dipping or inverted by F2
Boundary between structural units, steeply dipping or inverted by F3
Mesozoic rocks (undifferentiated)
Approximate outline of the Stelli zone (Monte Rosa Nappe s.s.)
③ Saas area
S-'M' Salarioli-'Mulde'
④ Eastern part of the Furgg zone
⑤ Eastern part of the Antrona Syncline and the Camughera-Moncucco Complex
For the remaining symbols, see the legend of Map 1, and the legend of the maps 1:25,000


MAP 3
Structural map of the Saas area
1:25,000
J.A.Klein
0 1 2
km
Topographic base after:
Landeskarte der Schweiz 1:25,000, Blatt 1329 Saas (1970)
Boundaries between subareas
④ Numbers of subareas
Consulted maps and papers (applies also to Map 4 and Map 5):
Geologischer Atlas der Schweiz 1:25,000
Blatt Saas (Bearth 1954) and map explanation (Bearth 1957)
Carta Geologica d'Italia 1:100,000,
Foglio 15, Domodossola (Novarese & Stella 1890-1910, Ristampa 1959)
Amstutz (1950, 1954) Bearth (1952a, 1956a, 1964, 1967) Blumenthal (1952)
Güller (1947) Te Kan Huang (1935) Wetzel (1972)




MAP 5
Structural map of the eastern parts of the Antrona Syncline and the Camughera-Moncucco Complex.
1 : 25,000
J.A.Klein
0 1 2
km
Topographic base after:
Carta d' Italia 1:25,000 Fogli Domodossola 15 II NO, Villadossola 15 II SO, Bognanco 15 III NE, Antronapiana 15 III SE (Edizione 2)

LEGEND

- Mesozoic metasediments, a) carbonaceous, b) quartzitic, not everywhere differentiated
- Mesozoic mafic rocks and their metamorphic equivalents
- Mesozoic serpentinites
- Furgg zone
- Orthogneisses, aplitic to granodioritic composition
- Paragneisses and schists
- Idem, with intercalated amphibolites
- Individual amphibolite bodies
- Ultramafic body of Montescheno

For a detailed specification of these rock-types and particulars on their age and metamorphism, see the legend of Enclosure 1

S-'M'	Salarioli-'Mulde'	ASF	Augengneiss of Saas Fee
B	Bernhard Nappe	PGz	Portjengrat zone
Fz	Furgg zone	MR	Monte Rosa Nappe s.s.
Cz	Camughera zone	ML	Monte Leone Nappe
Mz	Moncucco zone	AN	Antrona amphibolites

STRUCTURAL SYMBOLS

- S_1 angle of dip <30°, 30°-60°, >60°
- Axial plane of F_2 fold, idem a) not measured b) measured
- S_2 axial-plane schistosity, idem
- S_1 parallel to S_2 axial-plane schistosity, idem. Not everywhere differentiated
- 'Shear' S_2 in Saas area (see 3.4.1.), dip always <30°
- Axial-plane F_3 and F_3' folds
- F_1 fold axis, angle of plunge <30°, 30°-60°, >60°
- F_2 fold axis, idem
- F_3 and F_3' fold axis, angle of plunge <30°, 30°-60°
- Axial-plane trace of F_1 fold, a) observed, b) inferred, c) likely but not investigated
- Axial-plane trace of F_2 fold, idem
- Axial-plane trace of F_3 fold, idem
- a) Antiform b) Synform, c) Vertical fold (closure in the direction of the arrows).
- Boundary of major structural units, a) observed, b) inferred or after previous authors
- Syn-nappe movement zones
- Boundary between rock-types, a) observed, b) inferred
- Formline of folded S_1 a) observed b) inferred
- F_1 mesoscopic fold, true asymmetry indicated
- 1-34 Numbers of fold hinges, in red F_2, in black F_1 or F_3
- Fault

Drawn by B.G.Henning