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GEOLOGY OF THE KETTLE FALLS, MARCUS, COLVILLE, AND ECHO VALLEY QUADRANGLES, NORTHEAST WASHINGTON

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Rocks of the map area range in age from Precambrian to Eocene. Though complicated by faulting and multiple folding, the rocks of the highlands range from Precambrian, Cambrian, and Ordovician in the south and east to Permian and Triassic in the center and northwest. At lower elevations, in the Colville Valley between Kettle Falls and Colville, and at higher elevations along and beyond the north boundary of the map area, are extensive outcroppings of Eocene volcanic and volcaniclastic rocks bounded by major faults and quite unaffected by the folding that deformed the Triassic and older rocks.

Paleozoic metasedimentary rocks of the map area include quartzite, argillite, siltite, phyllite, limestone, and dolomite ranging in age from Precambrian to Ordovician and Devonian through Permian. Mesozoic metasedimentary rocks include argillite, siltite, graywacke, chert-pebble conglomerate, and limestone of Triassic age. Metavolcanic and volcaniclastic rocks and associated limestone pods make up large parts of the Echo Valley quadrangle and much lesser parts of the adjacent quadrangles. Their age could not be determined on fossil evidence, but their position and deformation indicate that they probably are all Devonian or younger and pre-Permian in age.

Along the west boundary of the Marcus quadrangle and separated from the rocks of the rest of the quadrangle by a zone of major north/south faulting are numerous outcrops of quartzite, gneiss, amphibolite, and marble of unknown age. They constitute large parts of the Boyds and Bangs Mountain quadrangles to the west and southwest of those mapped here.

The presence of extensive bedrock cover, numerous major faults, and multiple folding combine to conceal and disrupt the rock sequences so as to make geologic correlation and interpretation difficult. The oldest of the major faults are the thrust faults in the Kettle Falls and Colville quadrangles. They are post-Ordovician and pre-Eocene in age. They are truncated by a family of generally north-trending high-angle faults, some of which offset the Eocene rocks of the Echo Valley quadrangle. In turn, the north-south faults are truncated by post-Eocene high-angle faults that trend slightly north of west, as exemplified by the faults bounding the graben containing the Eocene volcanic sequence between Kettle Falls and Colville.

Most of the strata in the four quadrangles have been subjected to two major fold deformations, and probably at least one further mild deformation of local significance. The record of this multiple folding is less well recognized in the eastern quadrangles (Colville and Echo Valley), mostly because as yet we have insufficient data on bedding and foliation attitudes. This lack is to be remedied by further field studies during the 1983 field season. However, none of the data gathered so far differ materially from those gathered in the two western quadrangles, a discussion of which follows.

Bedding, foliation, and fold-axis data were gathered from three domains north of the Colville Valley (mostly in the Marcus quadrangle) and from three domains in the south half of the Kettle Falls quadrangle. All of the data were obtained from the metasedimentary rocks ranging in age from Precambrian to Triassic. These data (669 bedding poles, 157 foliation poles, and 36 fold-axis attitudes) were plotted on 11 stereograms** from which certain conclusions and observations are drawn which are fully in

accord with the fold structures observed in the field, the more pronounced of which are shown on the accompanying map. The observations and conclusions are as follows:

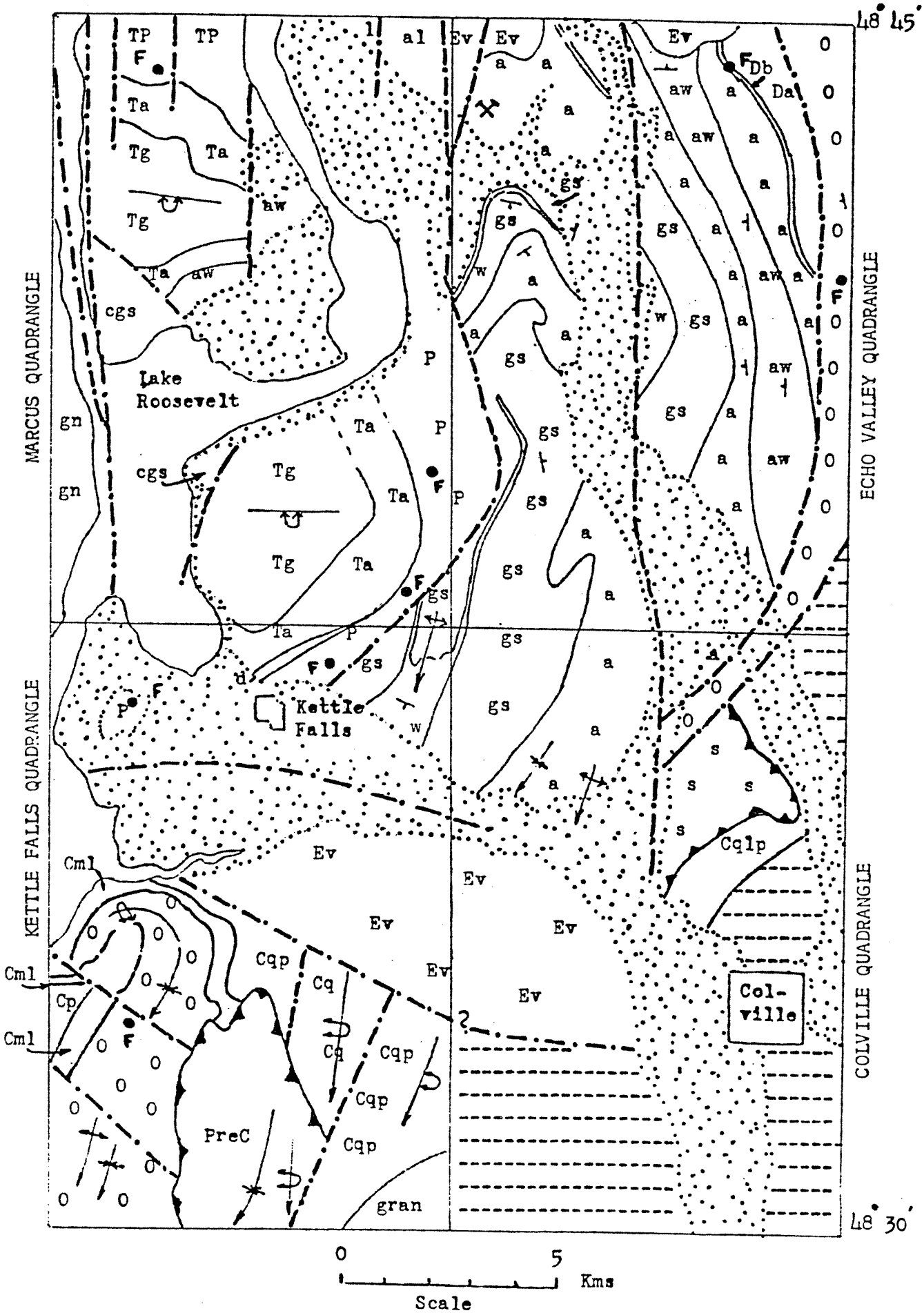
1. All first-stage folds are very tightly appressed, isoclinal, or overturned.
2. First-stage folds in the Marcus quadrangle are almost isoclinal and overturned to the south, with gentle plunges to the east or west.
3. First-stage folds in the south half of the Kettle Falls quadrangle are equally tightly appressed , but they are upright, plunging south rather than east or west.
4. In both the Kettle Falls and Marcus quadrangles, second-stage folds are very open and upright and plunge gently to moderately south-southwest. They overprint the first-stage folds. The effect of the second-stage folding is more pronounced and obvious where the second-stage fold trends are at a high angle to the first-stage fold axes (Marcus quadrangle), rather than where folds of the first and second stages are within about 20 degrees of being co-axial (south Kettle Falls quadrangle).
5. A third folding phase is expressed locally as minor kinking or flexing; it plays no significant role in determining rock distribution and is given no further attention.
6. Rocks as young as Triassic are affected by the two major fold events, but the Eocene rocks are unaffected. In all likelihood both major fold events--like those elsewhere in northern Stevens County where fold structures are truncated by Cretaceous granite and granodiorite batholiths--took place during the late Triassic to early Cretaceous.

7. Rocks of the metamorphic sequence in westernmost Marcus quadrangle rarely display bedding, but where beds can be seen they are observed to be flexed into open, symmetrical, upright folds plunging at low angles to the south-southeast or north-northwest. On the other hand, foliation and layering are well developed throughout, dipping gently (0-30°) in various directions. Neither the style or the attitude of these flexures seems to match the folds in the rest of the map area.

* The geology of the Kettle Falls and Marcus quadrangles was mapped by the author. The resulting maps (scale 1 inch = 2000 feet) and report are being prepared for publication by the Washington Department of Natural Resources. The geology of Echo Valley and the north half of the Colville quadrangles was mapped by the author and by the following men in partial fulfillment of the requirements for the degree of Master of Science in Geology, Washington State University: R.C. Brainard, G.W. Duncan, C.E. Hogge, and E.R. Laskowski.

** These stereograms are illustrated and discussed in detail in a forthcoming publication of the Division of Mines and Geology. Only the conclusions are reported here.

NOTE: The publication referred to above is Geologic Map GM-32, Geologic maps of the Marcus and Kettle Falls quadrangles, Stevens and Ferry Counties, Washington by J. W. Mills, 1985. Published by Washington Division of Geology and Earth Resources.


48° 45'
48° 30'
MARCUS QUADRANGLE
ECHO VALLEY QUADRANGLE
KETTLE FALLS QUADRANGLE
COLVILLE QUADRANGLE
Lake Roosevelt
Kettle Falls
Col-ville
TP
Ta
Tg
aw
cgs
gn
P
gs
w
Ev
a
Db
Da
Cml
Cp
Cq
Cqp
Cqlp
PreC
gran
s
0
5
Kms
Scale

LEGEND

SYMBOL	DESCRIPTION	FORMATION	AGE
⁘	SILT, SAND, GRAVEL		PLEISTOCENE
Ev	DACITE, TUFF, VOLCANIC BRECCIA SANDSTONE, CONGLOMERATE	SAN POIL VOLCANICS	EOCENE
d	DIABASE		TERTIARY
Tg	SILTSTONE, GRAYWACKE		TRIASSIC
Ta	ARGILLITE		TRIASSIC
TP	ARGILLITE AND LIMESTONE		TRIASSIC AND/ OR PERMIAN
P	ARGILLITE AND LIMESTONE		PERMIAN
Db	ARGILLITE, LIMESTONE, AND BARITE		DEVONIAN
Da	ARGILLITE		DEVONIAN
O	ARGILLITE, MINOR SILTSTONE	LEDBETTER	ORDOVICIAN
Cml	LIMESTONE, MINOR DOLOMITE	METALINE	CAMBRIAN
Cqlp	(PHYLLITE	MAITLEN	CAMBRIAN
	(LIMESTONE	REEVES	CAMBRIAN
	(QUARTZITE	ADDY	CAMBRIAN
Cqp	QUARTZITE AND PHYLLITE	ADDY/MAITLEN	CAMBRIAN
Cq	QUARTZITE	ADDY	CAMBRIAN
PreC	DOLOMITE, QUARTZITE, GREENSTONE, LIMESTONE, PHYLLITE		PRECAMBRIAN
a	ARGILLITE		DEVONIAN?
w	WACKE		DEVONIAN?
aw	ARGILLITE AND WACKE		DEVONIAN?
gs	METABASALT WITH SINGLE QUARTZ WACKE UNIT		?
cgs	METABASALT AND CHERT		?
l, al	LIMESTONE, ARGILLITE AND LIMESTONE		?
gn	GNEISS, AMPHIBOLITE, QUARTZITE, MARBLE		?
s	SILTSTONE		?
gran	GRANITE		TERTIARY?

BONANZA MINE

F FOSSIL LOCALITY

FAULT

THRUST FAULT

FOLD AXIS, ANTICLINAL

FOLD AXIS, SYNCLINAL

FOLD AXIS, ANTICLINAL, OVERTURNED

FOLD AXIS, SYNCLINAL, OVERTURNED

NOT MAPPED