Igneous Intrusions of Jewett and Aneroid Lakes Area, Wallawa Mountains, Oregon

Laura Dodds
College of Wooster

Introduction

The igneous intrusions described in this study, are located in a one-half square mile area roughly between the Jewett and Aneroid cirque lakes in the Eagle Cap Wilderness Area, Wallawa Mountains, Northeastern Oregon. Elevation in this area is 7600-8400 feet above sea level. The area of study is on the edge of the Cretaceous Wallawa Batholith, situated so as to include both a section of the batholith and its contact with metasedimentary Triassic and Jurassic rocks that are intruded by other igneous dikes. (See fig. 1.1.) Methods used are mapping igneous dike occurrence on topographic map base, sampling, field description, and lab analysis utilizing petrographic and ICP-AES (Inductively Coupled Plasma Atomic Emissions Spectrometry) chemical analysis techniques. Directors of this project are Dr. John Winter of Whitman College, Dr. Steven Weaver of Beloit College, and Dr. Peter Crowley of Amherst College. My specific project advisors are Dr. Frank Koucky of College of Wooster and Dr. Steven Weaver. The objectives of my study are: to describe all igneous intrusions in this area of batholith or prebatholith age, to interpret their relationships to each other, and to interpret their origin.

Field Methods

Mapping of igneous dikes and sedimentary contacts was conducted of the field area on foot. Strike measurements were taken of dikes, and intrusions were sketched on to a topographic map. Several representative samples were taken of each type of intrusion in the area. Sample locations and other locations important to the determination of age relationships, such as cross cutting relationships, were marked on the map. Photographs and notes were taken of cross-cutting relationships when possible and sketches as well as notes supplement observations.

Field Interpretation

The field interpretation is that there are six distinguishable types of igneous intrusions: 1) lineated, fine grained, mafic dikes 2) lineated, fine grained, leucocratic, felsic dikes 3) unmetamorphosed, batholith stock, main phase 4) unmetamorphosed, leucocratic, felsic dikes, tangential to the batholith stock 5) pegmatite veins, composed mostly of feldspar, and 6) a lineated, brown, more silicious dike, (determined later through thin section analysis not to be an igneous dike, but a silicified joint.)

In the order of age, from oldest to youngest, as determined from cross-cutting relationships they are: 1) fine grained, darker mafic dikes, 2) fine grained, leucocratic, felsic dikes, 3) batholith stock, main phase and batholith related dikes tangential to the batholith stock, 4) unmetamorphosed pegmatite veins within the batholith stock. The age relationship of the brown, more silicious (pseudo) intrusion with respect to the other intrusions is indeterminable. Columbia River Basalt Dikes also cut the area. These are mapped but not sampled because they have already been extensively studied and are without a doubt younger than all other igneous intrusions in the area (Reidel and Hooper, 1989). Previous studies in this area have not included prebatholith igneous dikes (Taubeneck, 1964). My interest in study lies in batholith and prebatholith intrusions.

Lab Analysis

Chemical analysis by method of ICP-AES (Inductively Coupled Plasma Atomic Emissions Spectrometry) has been carried out. Petrographic thin section analysis, because of fine grain size, has been supplemented with x-ray diffraction analysis and a normative mineralogy study. A discussion of the relationship of the normative mineralogy to the actual mineralogy will be presented at the 1991 Keck consortium. Data collected of normative mineralogy is listed in table 2.1 and of rock chemistry in table 2.2. Graphs 3.1 and 3.2 show representative plots of chemical data.

Chemical Data Interpretation

Harper plots of Fe_2O_3 and $Na_2O + K_2O$ are fairly representative examples of most of the chemical components harper plots, in that it presents a linear relationship between three groups: mafic, batholith, and leucocratic (meaning all others, including pegmatite veins). Both metamorphoseed and unmetamorphosed leucocratic, felsic dikes, as well as batholith pegmatites show a much closer relationship than previously expected. These are for the most part alike in terms of chemical composition. One difference between the metamorphosed and unmetamorphosed igneous intrusions is that the metamorphosed tend to be higher in sodium than potassium, and the unmetamorphosed higher in potassium than sodium.

Discussion

A close chemical affinity is observed in the dikes, batholith, and pegmatites. Since the batholith occurs in multiple stocks in this region, it is possible that the metamorphosed leucocratic, felsic dikes, could have been introduced by earlier batholith intrusions and metamorphosed by later intrusions of batholith stocks like the stock in my area. Intrusions of this region may show little variance.

limb. The fold axes appear to be spread over in a NE/SW trend. The orientations of the lineations are approximately perpendicular to the fold axes (figure 4).

Thin sections were cut from twenty oriented samples. In order to observe possible kinematic indicators, they were cut perpendicular to foliation and parallel to lineation where apparent, and parallel to the regional trend of lineations where lineation was not visible in the sample. Samples were collected from the Martin Bridge and the Hurwal, as well as numerous igneous dikes ranging from fine-grained intermediate composition to coarse grained felsic dikes that are most likely related to the batholith. The thin sections of the Martin Bridge samples showed evidence of extensive post kinematic recrystallization of calcite. This recrystalliztion appears as equant-shaped grains with regular extinction and 120° grain boundaries. Because of the proximity to the batholith, structural data present in the older rocks may have been destroyed by post kinematic reheating during the intrusion of the batholith.

The asymmetry of the structure and the orientation of local lineations are compatible with top to the west tectonic transport. This is consistent with deformation resulting from the emplacement of the Wallowa terrane onto the western continental margin of North America along an east-facing subduction zone.

REFERENCES

Armstrong, R.E., Taubeneck, W.H., and Hales, P.O., 1977. Rb-Sr and K-Ar geochronometry of Mesozoic granitic rocks and their Sr isotopic composition, Oregon, Washington, and Idaho: GSA Bulletin, v. 88, p. 397-411.

Jones, David L, Silberling, N.J., Hillhouse, J., 1977. Wrangellia--A displaced terrane in northwestern North America: Canadian Journal of Earth Sciences, v. 14, p. 2565-2577.

Mirkin, AS, 1986. Structural analysis of the East Eagle Creek area, southern Wallowa Mountains, NE Oregon. Rice Univ MS thesis. 116 p.

Ross, CP,1938. The Geology of part of the Wallowa Mountains, State of Oregon, Dept. of Geology and Mineral Industries: Bulletin #3.

Sarewitz, Daniel, November, 1983. Seven Devils terrane: Is it really a piece of Wrangellia?: Geology, v. 11, p. 634-637.

Smith, Warren Du Pre et al, 1941. Geology and Physiography of the Northern Wallowa Mountains, Oregon, State of Oregon, Dept. of Geology and Mineral Industries: Bulletin # 12.

Strayer, Luther M., Hyndman, D.W., Sears, J.W. and Myers, P.E., November 1989. Direction and shear sense during suturing of the Seven Devils-Wallowa terrane against North America in western Idaho: Geology, v. 17, p. 1025-1028.

Whalen, Michael T., July 1988. Depositional history of an Upper Triassic drowned carbonate platform sequence: Wallowa terrane, Oregon and Idaho: GSA Bulletin, v. 100, p. 1097-1110.

References

Reidel, Stephen P., Hooper, Peter R., 1989, Volcanism and Tectonism in the Columbia River Flood-Basal Province, The Geological Society of America Special Paper 239, The Geological Society of America, Boulder Colorado.

Taubeneck, William H., 1964, Cornocopia Stock, Wallowa Mountains, Northeastern Oregon: Field Relationships, Geological Society of America Bulletin, v. 75, p. 1093-1116.

Legend for Fig 1.1

□	Martin Bridge Ls, late Triassic, locally metamorphosed to marble
▦	Hurwal Fm, late Triassic, metamorphosed siltstone
········	mafic dikes
⁖	batholith stock with pegmatite veins throughout
—··—··—··	unmetamorphosed, leucocratic, felsic dikes
—·—·—·—	metamorphosed, leucocratic, felsic dikes
	Columbia River Basalt
■	lakes (note: the unnamed lake is not Aneroid Lake, which is larger and located North, just outside the mapped area)
——	rock type contacts
180' ←→	scale

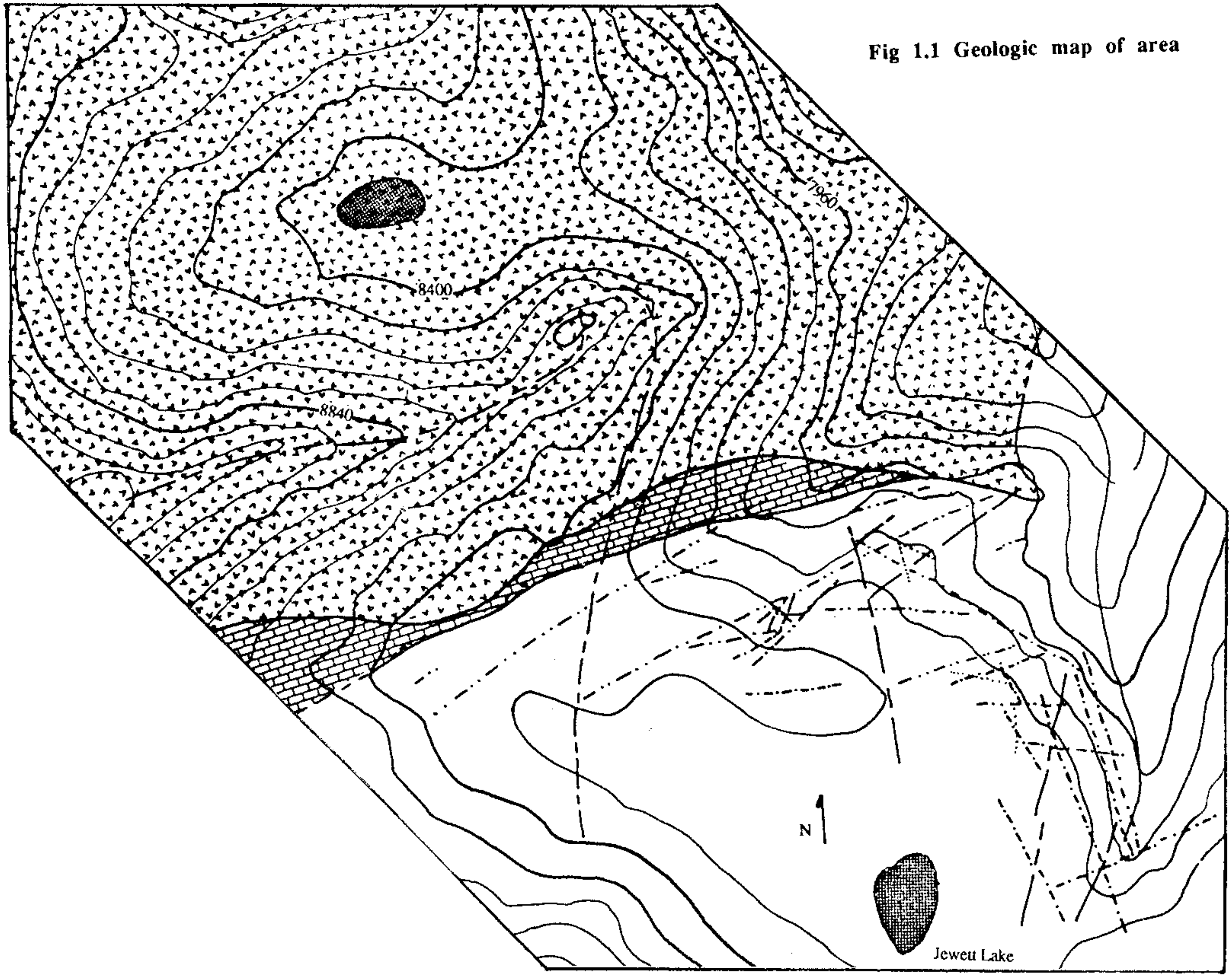


Fig 1.1 Geologic map of area

Fig 2.1 Normative mineralogy

sample	An	Q	or	ab	an	C	di	hv	wo	ol	il	hem	ti	ap	ru
LD-TR	6.8	29.1	13.5	49.8	3.6	1.8	0	0.6	0	0	0.2	0.9	0	0.2	0
LD-5b	32.5	36.6	9.7	35.3	17	0	0.4	0	0.1	0	0	0.3	0.2	0	0
LD-7	7	25.2	17.7	48.8	3.7	2.4	0	0.6	0	0	0.2	0.9	0	0.2	0
LD-17i	0	18.03	16.49	55.93	5.07	0.4	0	2.36	0	0	1.5	0	0	0.21	0
LD-44	0	73.6	0	0	0	16	0	0	0	0	0.1	0.8	0	0	0
LD-45	8.4	26.6	15.5	48.7	4.5	2.2	0	0.9	0	0	0.1	1	0	0.2	0
LD-47	8	26.6	15.5	48.7	4.5	2.2	0	0.9	0	0	0.1	1	0	0.2	0
LD-16	32.1	35.5	11.2	33.6	15.9	0.3	0	1.5	0	0	0.1	1.7	0	0.2	0.1
LD-16b	13.7	25.7	17.3	45.6	7.3	0.5	0	1.3	0	0	0.1	1.6	0	0.2	0.1
LD-17b	29.8	30.6	30.8	26.2	11.1	0	0.2	0.1	0	0	0	0.4	0.2	0.1	0
LD-55	12.6	26.2	25.8	40.5	5.8	0	0.3	0.1	0	0	0	0.6	0.1	0	0
LD-50-A	12.3	31.4	28.1	33.7	4.7	0.4	0	0.2	0	0	0.1	0.5	0	0.4	0
LD-1	11.5	25.5	33	34.9	4.5	0	0.3	0.1	0	0	0	1.1	0.1	0.1	0
LD-52	20.7	32.7	30.8	27.5	7.2	0	0	0.4	0	0	0.1	0.9	0	0	0.1
LD-4	14.5	21	45.6	27.2	4.6	0	0.3	0.2	0	0	0	1.1	0.1	0.1	0
LD-50-B	42.2	9	5.6	38.1	28.7	0	3.9	6.5	0	0	0	5.3	1.3	0	0
LD-2	38.8	12.5	11.4	38.1	24.1	0	1.6	5.8	0	0	0.2	4.7	1	0.4	0
LD-42	89.9	0	6.6	4	35.5	0	24.2	1.4	0	14.1	0	12.2	0.2	0.2	0
LD-29	60.7	0	8.2	19.9	30.6	0	12	0	0	15.9	0.3	10.9	0	0.3	1

Fig 2.2 Rock chemistry

sample number	% SiO2	% Al2O3	% Fe2O3	% MgO	% CaO	% Na2O	% K2O	% TiO2
LD-TR	74	15	1	0	1	6	2	0
LD-5b	75	15	0	0	4	4	2	0
LD-7	72	16	1	0	1	6	3	0
LD-17i	71	16	1	0	1	7	3	0
LD-44	74	16	1	0	1	5	3	0
LD-45	73	16	1	0	1	6	3	0
LD-47	72	17	1	0	1	5	3	0
LD-16	74	17	2	1	3	4	2	0
LD-16b	72	15	2	1	2	5	3	0
LD-17b	74	15	0	0	2	3	5	0
LD-55	74	15	1	0	1	5	4	0
LD-50-A	75	14	1	0	1	4	5	0
LD-1	73	14	1	0	1	4	6	0
LD-52	75	14	1	0	2	3	5	0
LD-4	71	15	1	0	1	3	8	0
LD-50-B	58	19	5	3	7	5	1	1
LD-2	61	18	5	3	6	5	2	1
LD-42	43	15	12	13	14	0	1	1
LD-29	46	17	11	11	10	3	1	1

ppm MnO	% P2O5	ppm Ba	ppm Sr	ppm V	ppm Cr	ppm Ni	ppm Ce	ppm Y
0	0	543	428	3	7	10	24	8
0	0	4700	1063	4	4	6	14	5
0	0	1680	440	4	5	6	30	8
0	0	679	387	3	7	9	28	7
0	0	917	430	3	18	7	24	8
0	0	628	480	4	18	15	49	8
0	0	705	362	4	14	11	29	8
0	0	632	740	11	4	8	38	10
0	0	1147	506	13	13	11	42	10
0	0	1161	884	3	6	7	7	4
0	0	210	88	3	6	7	24	5
0	0	341	105	6	7	7	20	10
0	0	115	550	7	9	11	3	7
0	0	355	933	8	6	7	27	11
0	0	176	80	7	4	4	20	28
0	1	279	738	109	29	32	22	14
0	1	506	740	97	18	18	23	14
0	1	390	619	201	904	278	19	18
0	1	227	572	287	457	110	16	16

ppm La	ppm Co	ppm Sc	ppm Yb	ppm Be
0	0	2	63	2.57
4	0	0	55	2.89
0	0	2	64	2.89
0	0	1	.65	2.80
0	0	2	70	2.50
13	0	1	73	2.45
0	0	2	67	2.24
17	0	3	97	1.80
13	0	3	94	2.17
0	0	1	.53	2.08
5	0	1	62	2.42
19	0	1	1.80	2.18
15	0	1	1.61	1.92
13	0	2	1.58	2.16
2	0	2	3.09	2.06
18	11	14	1.62	1.40
17	9	11	1.61	1.44
25	56	36	1.91	2.26
16	42	44	1.70	1.60

Fig 3.1 Harper plott of Fe2O3

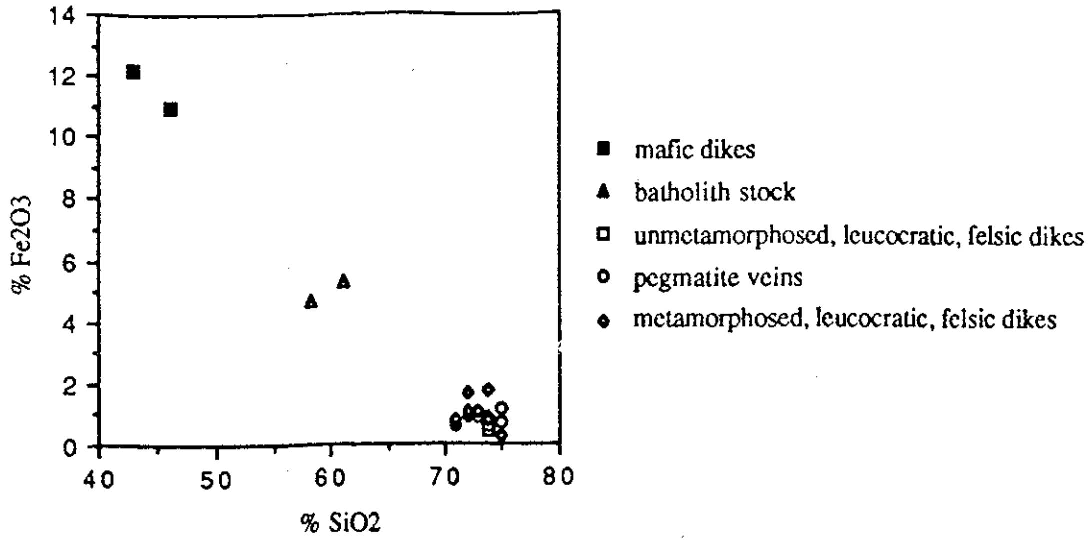
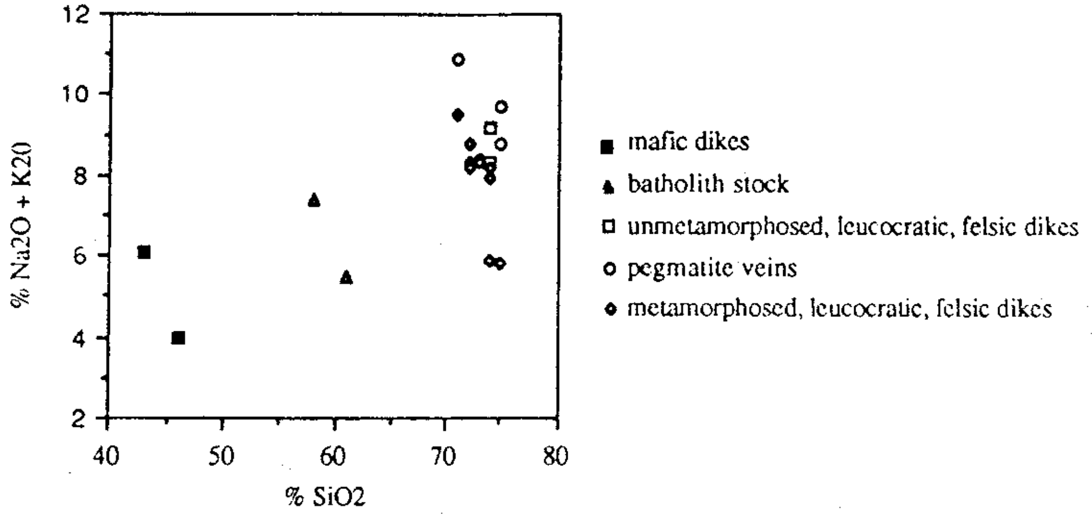


Fig 3.2 Harper plot of Na20 + K20



THE GEOLOGY OF PART OF THE EAGLE CAP WILDERNESS AREA, NORTHEASTERN OREGON

Jennifer Kleck
Geology Department
The Colorado College
Colorado Springs, CO 80903

Recently the western coast of North America has been shown to consist of a number of fault-bounded, stratigraphically distinct, allochthonous or suspect terranes (Coney et al., 1989; Hillhouse et al., 1981). The present study attempts to describe and analyze in detail the geology of a small area located in northeastern Oregon, which may be part of an accreted island arc terrane. The field area (Figure 1) comprises deformed Triassic strata and abundant dikes.

Two sedimentary formations of Upper Triassic to Lower Jurassic age are exposed in the field area and are locally subdivided for the purpose of this study (Figure 2). Divisions are based on carbonate and argillite content and contacts are gradational. Both formations have been regionally metamorphosed and tremolite commonly occurs in argillaceous sediments.

The oldest exposed sedimentary formation is the Martin Bridge Limestone which is divided into two units based on argillite content. The lower unit consists of light-grey to white, nearly pure limestone with minor detrital quartz. Bedding is obscured by tectonic banding and carbonate grains, which range in size from < 1-3mm in diameter, are elongate parallel to banding. The lower contact of this unit in the field area is a fault contact; only a minimum thickness of 20m could be obtained. The upper Martin Bridge unit is a bluish-grey, thinly bedded, fine-grained limestone in which silty beds are common. No preferred orientation of grains is apparent in either handsample or thin section. This unit is approximately 20-25m.

The Hurwal Formation conformably overlies the Martin Bridge Limestone in gradational contact and has been divided into three units. The lower unit, 43-50m thick, is well bedded, tan and dark grey, with limestone and silt occurring in roughly equal proportions. Graded cycles 4-7cm thick are common, as are fossil bivalves. The middle unit comprises 58m of thin to medium bedded siltstone with common thin beds of limestone. Sedimentary structures include parallel laminations and cross-bedding which are commonly distorted by soft-sediment deformation. The upper Hurwal unit is rusty-weathering argillite; limy beds are uncommon. Bed thickness is generally 3-8cm but individual beds are as much as 20cm thick. Soft-sediment deformation, cross-bedding, climbing ripples, rip-up clasts, and parallel laminations are the dominant sedimentary features. The upper contact is nowhere observed in the field area. A minimum thickness of 50m was measured.

The sedimentary formations are marine in origin. The Martin Bridge Limestone is most recently interpreted as an island carbonate platform containing local reefs (Stanley and Senowbari-Daryan, 1986). While no reefs were observed in the field area, fossils were common. The Hurwal sediments were probably deposited by turbidity currents on a steep, unstable slope in deeper water than the carbonates were deposited in. This interpretation is supported by the common sequence of cross-beds over parallel laminations in the upper Hurwal which probably represents the B and C portions of the Bouma cycle. Additionally, rip-up clasts and soft sediment deformation indicate periods of rapid deposition such as is associated with turbidity currents.

The field area is characterized by regional shortening accommodated by thrust faults, folds, and cleavage (Figure 2). The dominant foliation in the field area is spaced cleavage. It is most prominantly developed in the upper Martin Bridge unit and in the lower and middle Hurwal units. Plotted on a stereonet, cleavage measurements show relatively little scatter with the average orientation being approximately N40E;35SE. Foliation in the lower Martin Bridge unit is penetrative, resulting from parallel alignment of elongate grains.

Stereonet plots of folded bedding indicate that major folds are generally non-cylindrical. Fold geometry is complicated by the ductile behavior of the carbonate units, particularly the lower Martin Bridge where it overlies a thrust fault. This unit forms folds of various shapes and sizes with widely scattered orientations. Dikes intruding this unit are folded and boudinaged parallel to foliation within the limestone. This boudinage suggests that there was significant flow along foliation as the fault propagated. Both the degree of boudinage and the degree of parallelism of dikes to banding increase with increasing proximity to the fault. With increasing argillite content, units behave less ductily. The folds exhibited by the Hurwal units are broad and open. Minor and parasitic folds