STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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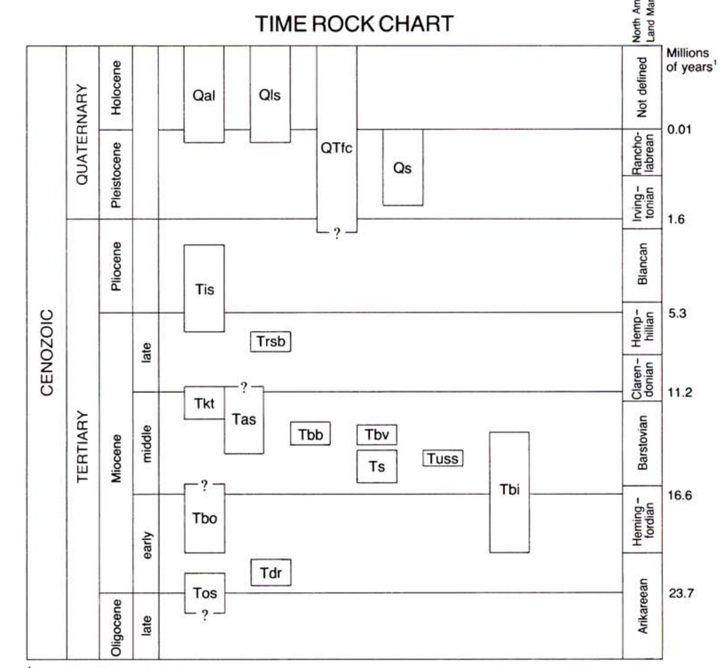
GEOLOGY AND MINERAL RESOURCES MAP OF THE OWYHEE DAM QUADRANGLE, MALHEUR COUNTY, OREGON

1989

GMS-55
Geology and Mineral Resources Map of the
Owyhee Dam Quadrangle, Malheur County, Oregon
By M.L. Ferns
Funded in part by the U.S. Geological Survey (COGEOMAP)



[1]Dates from Palmer (1983)

Base map by U.S. Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1966 and 1967. Field checked 1967
Polyconic projection. 1927 North American datum
10,000-foot grid based on Oregon coordinate system, south zone

UTM GRID AND 1967 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

Geology by Mark L. Ferns,
Oregon Department of Geology and Mineral Industries
Field work conducted in 1987-88

Table 1. Whole-rock analyses, Owyhee Dam quadrangle, Oregon[1]

Map letter	Field and laboratory no.	¼	¼	Sec.	T.(S.)	R.(E.)	UTM coordinates	Elev. (ft)	Lithology	Map unit	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	LOI	Total	Cr	Rb	Sr	Y	Zr	Nb	Ba
											Oxides (wt. percent)												Trace elements (ppm)						
A	87-B0-199	SE	NE	35	21	45	48385N 48586E	2,750	Olivine basalt	Tbb	53.9	16.5	1.09	8.76	0.15	8.21	4.98	1.46	2.98	0.30	0.85	99.3	139	34	493	<10	108	27	579
B	87-B0-131	NW	SW	30	22	46	483020N 48788E	3,600	Aphyric basalt	Tbb	55.3	16.5	1.17	9.00	0.16	7.75	4.29	1.36	3.22	0.41	0.85	100.2	72	22	502	15	129	26	696

[1]XRF analyses by XRAL.

Table 2. Trace-element analyses, Owyhee Dam quadrangle, Oregon[1]

Map no.	Laboratory no.	¼	¼	Sec.	T.(S.)	R.(E.)	UTM coordinates	Elev. (ft)	Lithology	Map unit	Ag (ppm)	As (ppm)	Au (ppb)	Cu (ppm)	Hg (ppm)	Mo (ppm)	Pb (ppm)	Sb (ppm)	Tl (ppm)	Zn (ppm)	Bi (ppm)	Cd (ppm)	Ga (ppm)	Pd (ppm)	Se (ppm)	Te (ppm)
1	AVB-228	SW	SE	15	21	45	484284N 48358E	2,840	Sinter	Tis	0.02	7.71	2	6.30	0.164	3.62	1.43	0.422	<0.473	3.94	<0.236	<0.095	2.13	<0.473	<0.945	<0.473
2	AVB-229	SW	SE	15	21	45	484284N 48358E	2,840	Conglom-erate	Tis	0.097	35.2	4	10.3	<0.098	2.57	4.86	0.996	<0.489	24.4	<0.245	<0.098	8.17	<0.489	<0.978	<0.489
3	AVB-227	SE	SE	14	21	45	484288N 48368E	2,440	Calcite	Tbo	<0.015	2.21	2	12.6	0.125	0.683	2.08	<0.245	<0.489	29.1	<0.245	<0.098	6.11	<0.489	<0.978	<0.489
4	AVB-226	NW	NE	24	21	46	484244N 48694E	2,560	Calcite and chalcedony	Trsb	0.015	4.70	2	27.5	<0.098	1.18	1.72	<0.246	<0.491	25.6	<0.246	<0.098	3.41	<0.491	<0.982	<0.491
5	AVB-231	NW	NW	29	21	45	484064N 47994E	2,840	Quartz and calcite	Tbb	0.023	1.65	4	12.9	<0.098	2.70	1.44	<0.245	<0.489	9.25	<0.245	<0.098	2.51	<0.489	<0.978	<0.489
6	AVB-230	NE	NE	33	21	45	483930N 48234E	3,120	Sinter (float)	Tis	0.044	135.	2	11.7	0.309	7.44	4.86	5.15	0.670	12.2	<0.242	<0.097	2.50	<0.484	<0.969	<0.484

[1]Gold analyses by Bondar-Clegg; other trace-element analyses by GSI.

EXPLANATION

Qal — **Alluvium (Pleistocene and Holocene)** — Unconsolidated and generally poorly sorted deposits of gravel, sand, and silt accumulated in flood plains of modern streams

Qls — **Landslide deposits (Pleistocene and Holocene)** — Landslide and slump deposits of unconsolidated and unstratified soil and angular rock fragments formed as the result of bedrock failure. Includes recent slump deposits related to water seepage from the Owyhee irrigation canal

QTfc — **Colluvial and alluvial fan deposits (Pliocene?, Pleistocene, and Holocene)** — Includes alluvial fan and slope deposits consisting of unconsolidated coarse gravels and silts deposited by periodic flash floods along Coyote Gulch. Colluvial deposits include talus along the banks of the Owyhee River. Also includes thick accumulations of wind-blown silt and sand in the northeast quarter of the quadrangle and near Deer Butte Spring

Qs — **Unconsolidated and poorly consolidated silt and sandstones (Pleistocene)** — Mainly unconsolidated flood-plain deposits of silt and sand deposited above the existing flood plain of the Owyhee River. May be in part correlative with the Bruneau Formation of Malde and Powers (1962) and the sedimentary rocks of Captain Keeney Pass (Brown, 1982). Represents part of an older floor of the Snake River Plain that is now being dissected by modern streams

Tis — **Tuffaceous sedimentary rocks (upper Miocene and Pliocene)** — Poorly to well-consolidated, light-gray to grayish-white, fine-grained tuffaceous sandstones, conglomerates, siltstones, mudstones, diatomaceous siltstone, and tuff. Mainly pebble conglomerates with black chert, basalt, granite, quartz, and rhyolite pebbles ¼-in. in diameter and angular fragments of petrified wood. Locally includes medium-grained cross-bedded arkosic sandstone and interbedded fossiliferous calcareous sandstone. Conglomerates and sandstones take on a yellowish hue and form resistant outcrops where silica and/or carbonate cement has been introduced by hydrothermal systems (e.g., Deer Butte and Pinnacle Point). Correlative with units in the upper part of the Idaho Group, including the Chalk Butte Formation (Corcoran and others, 1962) and the Glenns Ferry and Chalk Hills Formations of Malde and Powers (1962). Chert pebble conglomerates and overlying tuffaceous sandstones and siltstones at Deer Butte are equivalent to unit **Tig**, as mapped in the Adrian quadrangle, while underlying tuffaceous siltstones are equivalent to the lacustrine sediments of unit **Tic**, as mapped in the Adrian (Ferns, in preparation) and Owyhee Ridge quadrangles (Ferns, 1988). Late Miocene and Pliocene ages are based on fish fossils from the Adrian area (Kimmel, 1982)

Trsb — **Basalts (upper Miocene)** — Includes black to bluish- and greenish-black holocrystalline basalt flows and thin tuffaceous sand and siltstone and granite-clast pebble conglomerate interbeds. Individual flows are characteristically marked by basal red zones up to 3 ft thick. Flows generally contain plagioclase, clinopyroxene, and altered olivine phenocrysts with pilotaxitic to hyalophitic textures. The unit is correlative with the younger part of the Grassy Mountain Basalt of Bryan (1929) and basalt flows in both the Grassy Mountain Formation and the Deer Butte Formation of Kittleman and others (1965). A radiometric K/Ar date of 7.6±0.5 Ma is reported by Fiebelkorn and others (1982) for an olivine basalt in presumably the same stratigraphic position to the west. Geochemical analyses (Hart, 1981; Kittleman, unpublished data, 1983) indicate that the flows are olivine tholeiites (43.5-48.8 percent SiO_2; 14.23-15.93 percent Al_2O_3; 1.46-3.07 percent TiO_2; and 0.30-1.26 percent K_2O)

Tkt — **Tuff, tuffaceous sandstones, and siltstones (middle and upper Miocene)** — Mainly nonwelded, fine-grained, white to pale-yellow lithic tuffs containing basalt, banded rhyolite, and inflated white pumice clasts and biotite, quartz, and feldspar crystals. Includes thinly bedded airfall tuffs at the base of the unit and overlying thin lenses of tuffaceous sandstones. The unit is about 100 ft thick near Deer Butte Spring and thins rapidly to the east, where it wedges out. Correlative with the Kern Basin sediments of Corcoran and others (1962) and the basal tuff breccia in the Grassy Mountain Formation of Kittleman and others (1965). Age is middle Miocene based on a K/Ar date of 10.18±1.72 Ma for an overlying basalt flow (Hart, 1981)

Tas — **Arkosic and tuffaceous sandstones, siltstones, and conglomerates (middle and upper? Miocene)** — Mainly reddish-weathering, white to tan arkosic sandstones and granite-clast conglomerates with interbedded white tuffaceous sandstones and tuff. Includes 20-ft-thick massive beds of coarse, matrix-supported granite-clast conglomerates near exposed base of the unit. Generally fines upward into medium- to coarse-grained biotite-bearing arkosic sandstones. Locally includes thin tuffaceous siltstone and bentonitic clay interbeds and discontinuous lenses of white airfall tuffs that may be correlative with unit **Tkt**. Differentiated from conglomerates of unit **Tis** by absence of black chert clasts. The strata that comprise the unit have been called the Pinnacle Point beds by Baldwin (1959), the Sucker Creek Formation by Corcoran and others (1962), and the Deer Butte Formation by Kittleman (1962). The unit fills an erosional surface into the Owyhee Basalt (unit **Tbo**) and is locally interbedded with flows of unit **Tbb**. Middle Miocene age is based on Barstovian mammalian fossils from Tunnel Point (Corcoran and others, 1962) and from Oxbow Basin in the Twin Spring quadrangle (Kittleman, 1962)

Tbb — **Basalt and basaltic andesite flows (middle Miocene)** — Mainly gray to black, vesicular, aphyric and plagioclase-phyric holocrystalline basalt flows that fill paleovalleys eroded into underlying units **Ts** and **Tbo**. Interlayered with arkosic sediments of unit **Tas** on Tunnel and Black Willow Creeks. Commonly gray in color on fresh surfaces due to abundant framework feldspars in the groundmass. Textures range from pilotaxitic to ophitic. Characterized by plagioclase phenocrysts less than 0.1 in. in length and microphenocrysts of clinopyroxene, orthopyroxene, and iddingsitized olivine. Samples from the capping flows in the Owyhee Reservoir quadrangle to the south, near Tunnel Creek (samples A and B, Table 1), and from the Dry Creek Arm area in the Twin Springs quadrangle (Hart, 1981, his samples H-9-52, H-9-53A, and H-9-53B) are calc-alkaline basalts with compositions similar to those of the underlying Owyhee Basalt (unit **Tbo**) flows analyzed by Brown and Petros (1985). SiO_2 contents range from 52.8 to 54.90 percent. Unit **Tbb** is correlative with the Blackjack Basalt of Bryan (1929) and the Deer Butte basalts and uppermost flows of the Owyhee Basalt as mapped by Kittleman and others (1965) and Corcoran and others (1962). Radiometric K/Ar dates summarized by Fiebelkorn and others (1982) for samples reported from the map area range from 13.8±0.3 to 16.1±0.9 Ma. Unit **Tbb** flows are distinguished from underlying flows of unit **Tbo** by generally fresher appearance due to thin weathering rinds, by abundance of olivine (up to 5 percent) as a phenocryst phase, and by the presence of narrow, discontinuous lenses of intervening tuffaceous and/or arkosic sedimentary rocks

Tbv — **Basaltic pyroclastic deposits (middle Miocene)** — Mainly massive, crudely stratified red agglomerate and agglutinate deposits made up of scoria, ash, and elongated black basaltic andesite blocks and bombs. Interpreted as local pyroclastic vents related to flows in unit **Tbb**

Tuss — **Tuffaceous siltstones (middle Miocene)** — Mainly pale-yellowish-white and pale-greenish-brown, fine-grained tuffaceous siltstones. Includes coarse, white lithic tuffs composed of white inflated pumice and aphyric black basalt and interbedded mafic lapilli tuffs. Also contains interbedded gray to grayish-white and green bentonite clay beds that weather to a characteristic popcorn texture

Ts — **Tuffaceous sedimentary rocks (middle Miocene)** — Mainly fine-grained, light-orange-brown tuffaceous sandstones and pale-yellowish-white zeolitic tuffs. Includes white zeolitic tuffs and tuff breccias and yellowish-brown palagonitic sandstones. Correlative with the Sucker Creek Formation of Kittleman and others (1965)

Tbo — **Basalt, basaltic andesite, and andesite flows and breccias (lower and middle? Miocene)** — Mainly dark-gray to black, fine-grained platy plagioclase-phyric lava flows and autoclastic breccias that characteristically weather to various shades of red and brown. Includes generally thin, lenticular subaerial tuff and scoria deposits and thick accumulations of welded agglutinates. Includes lenticular accumulations of nonwelded and welded scoria. Total thickness of unit is over 1,000 ft. Three lithologic packages that are apparent but have not been mapped separately include (1) a sequence of interbedded olivine basalt and agglomerate beds at the base of the unit south of the Owyhee Dam; (2) a sequence of irregularly shaped andesite and basaltic andesite flows, breccias, and interbedded accumulations of cinders, agglutinates, andesitic tuff breccias, and tephra overlying the olivine basalts to the north; and (3) a series of thin basalt flows that fill paleovalleys in the basaltic andesite and andesite flows farther to the northeast near where the siphon crosses the Owyhee River. Individual basaltic andesite and andesite flows are up to 100 ft thick and are hyalocrystalline. They contain plagioclase phenocrysts as much as 0.2 in. long and sparse phenocrysts of clinopyroxene and orthopyroxene. Olivine basalts are generally pilotaxitic and may contain both phenocryst and groundmass olivine. The tuff breccias are irregularly shaped, discontinuous accumulations of white tuff up to 100 ft thick that contain scoriaceous andesite blocks as much as 3 ft in diameter. Chemically, the lower basalt and basaltic andesite flows near the Owyhee Dam are calc-alkaline flows ranging from 50 to 56.69 percent SiO_2 (Brown and Petros, 1985). May be correlative with the basalt at Bishops Ranch exposed to the east, the mafic flows of the "unnamed igneous complex" of Kittleman and others (1965) that are exposed to the west in the Malheur River gorge, and the basalts and latites mapped by Ekren and others (1981) to the east in Idaho. Interpreted here as a partially dissected calc-alkaline volcanic basement upon which younger Miocene rhyolitic caldera systems (Vander Meulen and others, in preparation; Ferns, 1988) were formed. Published radiometric K/Ar dates for the Owyhee Basalt that range from 14.1 to 25.3 Ma (Fiebelkorn and others, 1982; Brown and Petros, 1985) are apparently from both overlying unit **Tbb** and underlying unit **Tos** as mapped by this author and do not directly date rocks belonging to unit **Tbo**. Age is early or middle Miocene, based on the 22.8±2.6-Ma date for underlying unit **Tdr** and the 15.3±0.6-Ma date for overlying unit **Tbb** (Brown and Petros, 1985)

Tdr — **Plagioclase rhyolite (lower Miocene)** — Mainly flow-foliated, red, glassy, generally aphyric rhyolite; best exposed along the abutments of the Owyhee Dam. Includes capping vitrophyre breccias. Rare phenocrysts include embayed plagioclase crystals from 0.01 to 0.2 in. long. Brown and Petros (1985) report a 22.8±2.6-Ma K/Ar date from this unit. According to Corcoran and others (1962) and Kittleman and others (1967), the distal end of the rhyolite overlies sedimentary rocks to the west and south

Tos — **Mafic tuffs and tuff breccias (hydrovolcanic deposit?) (upper Oligocene? and Miocene)** — Mainly brown to light-orange-brown, coarse- to medium-grained palagonitic breccias that contain plagioclase-phyric and aphanitic mafic volcanic clasts up to 2 ft in diameter. Underlies unit **Tbo** and interfingers, in part, with unit **Tdr**. Uppermost beds include a 3-ft-thick white rhyolitic lithic tuff that overlies unit **Tdr**. Contacts between the underlying mafic tuffs and tuff breccias are not exposed. Early Miocene age is based on a 22.8±2.6-Ma K/Ar date on overlying unit **Tdr** (Brown and Petros, 1985) and a 25.3±1.8-Ma K/Ar date (Fiebelkorn and others, 1982) for a basalt flow near the base of overlying unit **Tbo** that appears to be interlayered with volcaniclastic sedimentary rocks

Tbi — **Basalt and andesite dikes and sills (lower to middle Miocene)** — Mainly narrow, columnar-jointed, or platy andesite and basaltic andesite dikes and sills similar in composition to unit **Tbo** flows. Unit **Tbi** includes a massive aphyric andesite plug east of Deer Butte that may represent a volcanic neck. Also includes glassy dikes in the southeast part of the quadrangle apparently related to unit **Tbb**

Contact — Approximately located

Fault — Dashed where inferred; dotted where concealed; queried where doubtful; ball and bar on downthrown side

8 **Strike and dip of beds**

B **Location of whole-rock sample analyzed in Table 1**

6 **Location of mineralized sample analyzed in Table 2**

STRUCTURE

Several large-scale structural elements are present in the quadrangle. The oldest is a set of north-northeast-trending, down-to-the-east faults separating a horst of older unit **Tbo** from interbedded, younger units **Tbb** and **Tas** to the east. One of the major northeast-trending faults is best exposed near the siphon on Snively Gulch. Contact relationships in the southern part of the quadrangle, where flows of unit **Tbb** cross the fault with little displacement, suggest an old, periodically reactivated structure that was partially buried by the youngest flows of unit **Tbb** during the middle Miocene.

Two distinct structures affect the younger Pliocene sediments. The older appears to be a north-plunging anticline roughly coincident with the crest of Owyhee Ridge and Blackjack Butte. The anticline is cut by a series of small-displacement, N. 45°-60° W.-trending faults. Pliocene-Pleistocene hot springs appear to be localized where younger northwest-striking faults intersect the older, northeast-trending structures.

MINERAL RESOURCES

Outside of the casual collecting of various types of chalcedony, no mineral-resource production has occurred in the Owyhee Dam quadrangle. Potential mineral resources include geothermal energy, gold, and semiprecious gemstones.

Geothermal resources

Potentially valuable geothermal resources occur within the quadrangle. Active hot springs along the Owyhee River are undeveloped. These include Deer Butte Spring, which has a surface temperature of 79 °C, and Snively Hot Spring, with a surface temperature of 57 °C (Brown and others, 1980). These springs are hot enough to be used in direct heating applications and may indicate a potential for higher temperature fluids at depth.

Metallic mineral resources

Much of the northwest quarter of the quadrangle has been affected by hydrothermal fluids. Several hot-springs-type alteration zones are exposed west of the Owyhee River. A large area of silicified sandstone and conglomerate extends from Deer Butte southwesterly to Sand Hollow Creek. Some of the alteration zones may be related to the currently active hot-spring systems at Deer Butte and Snively Hot Springs. Large blocks of opaline sinter are scattered over a distance of 300 ft on the south side of Deer Butte along the north-trending fault north of Snively Hot Spring in the south half of sec. 15, T. 21 S., R. 45 E. (samples 3 and 4, Table 2). Sample 2, a silicified conglomerate, contained an anomalous (35.2 ppm) amount of arsenic. A sinter boulder (sample 6) from the conglomerate capping Pinnacle Point was also anomalous in arsenic (135 ppm).

A large calcite vein is exposed above Deer Butte Spring on the north side of the Owyhee River. The vein measures 3 ft in width and cuts a zone of altered basalt that contains seams and lenses of red jasper. An areally extensive zone of intensely altered basalt is exposed northwest of Pinnacle Point near the southwest quarter of sec. 20, T. 21 S., R. 45 E. Here, bleached and iron-stained vesicular basalt cut by numerous veins of chalcedonic quartz and calcite is exposed along a small stream bottom over a distance of about 600 ft. The veins are apparently randomly oriented and range from a quarter of an inch to over 2 ft in thickness. The basalt is locally overlain by a limonitic arkosic sandstone that is not cut by the veins. Unaltered tuffaceous and arkosic sandstones of unit **Tas** cap the alteration zone.

Nonmetallic mineral resources

Semiprecious gemstones in the form of agate and jasper are the main nonmetallic resource found in the Owyhee Dam quadrangle. Abundant float of brightly colored chalcedony and agate mantles the basalt surface in sec. 32, T. 21 S., R. 45 E.

The arkosic sands of unit **Tas**, best exposed in Sand Hollow and on Tunnel Creek, may be a silica sand resource. Where unaltered, the unit contains fine- to medium-grained, light-grayish-white sands composed of nearly equal amounts of quartz and feldspar with less than 2 percent rock fragments and mafic minerals (mainly biotite).

GEOCHEMISTRY

Sample preparation

Samples for whole-rock analysis (WRA) (Table 1) were crushed to minus ¼-in. in a steel-jawed Braun chipmunk crusher and split in a Jones-type splitter in the Oregon Department of Geology and Mineral Industries (DOGAMI) laboratory. A split of about 100 g of each sample was ground to minus 200 mesh in agate grinding media by X-ray Assay Laboratories (XRAL) of Don Mills, Ontario.

Samples for trace-element analysis (Table 2) were crushed to minus ¼-in. and split as indicated above. Each sample was ground to minus 200 mesh in chrome-steel grinding media in an Angstrom disc mill in the DOGAMI laboratory. Each minus-200-mesh split was split again to produce two subsamples: one for gold and one for the other trace elements to be determined.

Chemical analysis

Whole-rock analysis: X-ray fluorescence (XRF) analyses were performed by XRAL. XRAL used a fused button for its analyses (1.3 g of sample roasted at 950 °C for one hour, fused with 5 g of lithium tetraborate, and melt cast into a button). Loss on ignition (LOI) was determined by the roasting.

Trace-element analysis:

1. **Gold** — Bondar-Clegg, Ltd., of North Vancouver, British Columbia, performed the analyses for gold. The method employed was fire assay preconcentration of the gold in a 20-g sample (gold was collected in added silver), acid dissolution of the resulting bead, and a directly coupled plasma (DCP) emission spectrometer finish. The detection limit was 1 ppb.

2. **Other trace elements** — Geochemical Services, Inc., (GSI) of Torrance, California, performed the analyses for 15 other trace elements. The method emplcyed a proprietary acid dissolution/organic extraction of a 5-g sample. The finish was by induction coupled plasma (ICP) emission spectrometry. GSI considers the digestion to provide total metal contents except for gallium and thallium. The detection limit for a given element varies slightly as a result of GSI's monitoring process.

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GEOLOGIC CROSS SECTIONS