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Macaulay Creek thrust (Class B) No. 554

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Synopsis	The Macaulay Creek thrust is a south-dipping thrust fault that occurs in geologically complex multiply deformed rocks of the Northern Cascade Mountains. Where exposed, the fault separates Eocene sedimentary rocks in the hanging-wall from more highly deformed and metamorphosed Jurassic rocks in the footwall. Most of the existing information on the character and age of the Macaulay Creek thrust is from recent geologic mapping and field studies by Dragovich and others (1997 #6224; 1997 #6258). Based on geologic data and interpretation of seismic data from the Deming earthquake of April 14, 1990 (Qamar and Zollweg, 1990 #6266; Amadi, 1992 #6256), Dragovich and others (1997 #6224; 1997 #6258) suggested that the Macaulay Creek thrust was the principle causative structure for that recent earthquake and after shocks. They also suggested that the available geologic data might indicate earlier, latest Pleistocene to Holocene faulting events along the Macaulay Creek thrust. They noted, however,

	that they did not find evidence for surface rupture related to the Deming 1990 events. Although historic seismicity in the region of the Macaulay Creek thrust is well established, no unequivocal evidence for historic or earlier Quaternary surface offset along the Macaulay Creek thrust has been reported at this time. Consequently, the Macaulay Creek thrust is classified herein as a Class B structure until more detailed studies are conducted.
Name comments	The Macaulay Creek thrust is an exposed and inferred, south-dipping thrust fault that is mapped along the eastern flank of the Northern Cascade Mountains. Dragovich and others (1997 #6258) identified, mapped, and named this fault. The McCauley Creek thrust is also shown on a regional geologic map (1:250,000-scale) by Dragovich and others (2002 #5715). A 1:2,000,000-scale map of known or suspected faults of the Pacific Northwest by Rogers and others (1996 #4191) does not show the Macaulay Creek thrust, but does show a northeast-trending geophysical lineament inferred to be a fault, directly northwest of the Macaulay Creek thrust. Most of the mapped trace of the Macaulay Creek thrust is located within about 5 km to the west and northwest of Deming, Washington (Dragovich and others, 1997 #6258). The mapped trace of the Macaulay Creek thrust extends sinuously northward along and across the Nooksack River and extends farther north along the southeast flank of Sumas Mountain to a point about 4 km northwest of Deming, where it encounters and appears to be cut by the Smith Creek fault. On the basis of indirect geologic evidence, Dragovich and others (1997 #6224) suggested that Macaulay Creek thrust has a wider aerial extent than indicated by surface exposures and correlated seismicity. They further suggested that the this thrust fault has intercepted and utilized the older and higher angle Smith Creek and Boulder Creek faults, which may imply that these interconnected structures are not extinct. Only the mapped trace of the Macaulay Creek thrust, as shown on the geologic maps by Dragovich and others (1997 #6258; 2002 #5715), is shown and discussed herein.
County(s) and State(s)	WHATCOM COUNTY, WASHINGTON
Physiographic province(s)	PACIFIC BORDER CASCADE-SIERRA MOUNTAINS
Reliability of location	Good Compiled at 1:250,000 scale.

	Comments: Fault trace is from the 1:250,000-scale geologic map compilation by Dragovich and others (2002 #5715); fault trace was transferred directly onto a registered mylar overlay and digitized at 1:250,000 scale.
Geologic setting	The Macaulay Creek thrust occurs in the Northern Cascades Mountains of Washington, which are comprised of a series of pre-Tertiary accreted terranes, Cretaceous to mid-Tertiary metamorphic and plutonic complexes, and Cretaceous, Tertiary, and perhaps Quaternary, thrust and high-angle fault systems (Dragovich and others, 2002 #5715). More specifically, this thrust fault occurs in the western part of the Northwest Cascade system (Misch, 1966 #5696; Brown, 1987 #6271) that contains numerous and diverse, pre-Tertiary lithologic packages bounded by thrust faults (Dragovich and others, 1997 #6258). These thrust-bound packages were emplaced as nappes during the mid-Cretaceous and they locally include tight to isoclinal folds, mylonites, and cataclasites (Dragovich and others, 1997 #6258). Arksose, sandstone, and conglomerate of the Chuckanut Formation were deposited during Eocene deformation of this region, which involved regional dip-slip and strike-slip faulting. Later Tertiary faulting and folding dissected and further complicated structural relations and resulted in a cross-faulted and broken map pattern of rock units and thrust faults in this region. The Macaulay Creek thrust underlies the Eocene Chuckanut Formation and overlies older and more deformed and metamorphosed Jurassic rocks in this structurally complex, multiply deformed terrane. In map view, the Macaulay Creek thrust appears to be one of the cross-faulted and broken thrust faults. However, based on several geologic and geometric relations, as well as seismic data, Dragovich and others (1997 #6224; 1997 #6258) hypothesize that the Macaulay thrust and some of it's subsidiary faults were active during the 5.2-magnitude, Deming earthquake of April 14, 1990 and it's aftershocks. They further suggest that the Macaulay Creek thrust may now link with some high-angle faults that appear to cut it, which may imply that it is a reactivation and modification of a fault that initially formed during Tertiary deformation of this region.
Length (km)	4 km.
Average strike	N34°E
Sense of movement	Thrust

	Comments: Dragovich and others (1997 #6224; 1997 #6258) report evidence, such as folds and lineations along and near the fault, as well as interpretations of seismic data, which indicate northerly directed thrust movement of the hanging-wall relative to the footwall of the south-dipping Macaulay Creek thrust.
Dip	5°-45° *Comments:* Dip angles for the Macaulay Creek thrust have not been specifically reported, however, Dragovich and others (1997 #6258) show and report the fault as a south dipping thrust fault, and in a north-northeast striking cross section (B-B') they show the fault ranging in dip from about 5?-45?.
Paleoseismology studies	
Geomorphic expression	For the vicinity of the Macaulay Creek thrust, Dragovich and others (1997 #6224; 1997 #6258) report an anomalously high incidence of historic and prehistoric deep-seated landslides, local high altitudes of the Everson Interstade glaciomarine drift (latest Pleistocene) on geomorphically unusual (structurally uplifted) bedrock terraces, and the presence of fluvial sands in the glaciomarine drift. They interpret these features as geomorphic and sedimentational responses to Quaternary movement and seismic activity along the Macaulay Creek thrust. They cite more detailed studies of the landslides and drift deposits that support or permit this interpretation (e.g., Booth, 1987 #6273; Engebretson and others, 1995 #6259; Dethier and others, 1995 #6270; 1996 #6260; Kovenan, 1996 #6263; Kovenan and Easterbrook, 1996 #6264). The Macaulay Creek thrust has an inferred trace where it is shown in Holocene and Pleistocene deposits along the valley of the Nooksack River (Dragovich and others, 1997 #6258). No scarps or other geomorphic features have been reported in Quaternary deposits along the inferred trace of this fault.
Age of faulted surficial deposits	The Macaulay Creek thrust deforms and juxtaposes sedimentary rocks of the of Chuckanut Formation (Eocene) on semischist of Mount Josephine (Jurassic) (Dragovich and others, 1997 #6224;, 1997 #6258). The southern part of the mapped trace of the Macaulay Creek thrust is shown as an inferred fault in Holocene and Pleistocene deposits in the Nooksack River valley (Dragovich and others, 1997 #6258). Dragovich and others (1997 #6224; 1997 #6258) do not show or report any evidence for faulting of

	these Quaternary deposits and elsewhere the trace of the fault is located in bedrock. Dragovich and others (1997 #6224; 1997 #6258) report indirect evidence of faulting, such as anomalously abundant Holocene-historic landslides and anomalous altitudes and sediment relations of latest Pleistocene glaiomarine deposits in the vicinity of this fault. They interpret these features and relations as responses to latest Pleisocene-historic movement and seismicity along the Macaulay Creek thrust.
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* Based on geologic field studies and analysis and interpretation of seismic data for the 5.2-magnitude, Deming earthquake of April 14, 1990 and it's aftershocks, Dragovich and others (1997 #6224; 1997 #6258) hypothesized that the Macaulay Creek thrust was the causative structure of this historic earthquake. They noted, however, that they did not identify direct evidence for surface rupture related to these recent seismic events. Based on the seismic information (Qamar and Zollweg, 1990 #6266; Amadi, 1992 #6256), the main Deming shock probably occurred directly south of the mapped trace of the fault, at a depth of about 3 km, and near the base of the Chuckanut Formation. The base of the Chuckaunut Formation is also the stratigraphic position of the Macaulay Creek thrust to the north. Dragovich and others (1997 #6224; 1997 #6258) reported indirect evidence, such as anomalously abundant Holocene-historic landslides and variations in the altitude of, and composition of, latest Pleistocene glaciomarine deposits in the vicinity of the Macaulay Creek thrust. They interpreted these features and variations as effects and responses to latest Pleistocene-historic movements and seismicity along the Macaulay Creek thrust. Although historic seismicity in the region of the Macaulay Creek thrust is well established, evidence for historic and Quaternary surface offset along the Macaulay Creek thrust appears to be equivocal at this time. Consequently, the Macaulay Creek thrust is classified herein as a Class B structure until more detailed studies are conducted.
Recurrence interval	 *Comments:* Dragovich and others (1997 #6224; 1997 #6258) report map relations, observations, seismic data, and interpretations that may indicate latest Pleistocene to Holocene

	movement(s) and uplift, as well as historic activity (Deming earthquake of 1990), along the Macaulay Creek thrust.
Slip-rate category	Less than 0.2 mm/yr *Comments:* At this time, existing data and interpretations do not specifically address or constrain the slip-rate(s) of the Macaulay Creek thrust. Based mostly on this lack of information, a conservative <0.2 mm/yr slip-rate is assigned herein for possible Quaternary slip. However, data presented or summarized in Dragovich and others (1997 #6224; 1997 #6258), which suggest historic and earlier Quaternary movement along the fault, might favor a slip rate that exceeds the amount assigned.
Date and Compiler(s)	2003 David J. Lidke, U.S. Geological Survey
References	#6256 Amadi, E.E., 1992, The 1990 Noonsack Forks, Washington, earthquake sequence—Sequence geometry and temporal characteristics: Boise, Idaho, Boise State University, unpublished M.S. thesis, 103 p. #6273 Booth, D.B., 1987, Timing and processes of deglaciation along the southern margin of the Cordilleran ice sheet, *in* Ruddiman, W.F., and Wright, H.E., Jr., eds., North America and adjacent oceans during the last deglaciation: Boulder, Colorado, Geological Society of America, The Geology of North America, v. K-3, p. 71-90. #6271 Brown, E.H., 1987, Structural geology and accretionary history of the northwest Cascades system, Washington and British Columbia: Geological Society of America Bulletin, v. 99, p. 201-214. #6270 Dethier, D.P., Pessl, F., Jr., Keuler, R.F., Balzarini, M.A., and Pevear, D.R., 1995, Late Wisconsinan glaciomarine deposition and isostatic rebound, northern Puget Lowland, Washington: Geological Society of America Bulletin, v. 107, p. 1288-1303. #5715 Dragovich, J.D., Logan, R.L., Schasse, H.W., Walsh, T.J., Lingley, W.S., Jr., Norman, D.K., Gerstel, W.J., Lapen, T.J., Schuster, J.E., and Meyers, K.D., 2002, Geologic map of Washington—Northwest quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-50, 72 p. pamphlet, 3 sheets, scale 1:250,000.

#6258 Dragovich, J.D., Norman, D.K., Haugerud, R.A., and Pringle, P.T., 1997, Geologic map and interpreted geologic history of the Kendall and Deming 7.5-minute quadrangles, western Whatcom County, Washington: Washington Division of Geology and Earth Resources, Open-File Report 97-2, 39 p., 3 plates, scale 1:24,000.

#6224 Dragovich, J.D., Zollweg, J.E., Qamar, A.I., and Norman, D.K., 1997, The Macaulay Creek thrust, the 1990 5.2-magnitude Deming earthquake, and Quaternary geologic anomalies in the Deming area, western Whatcom County, Washington—Cause and effects?: Washington Geology, v. 25, no. 2, p. 15-27.

#6259 Engebretson, D.C., Easterbrook, D.J., and Kovanen, D.J., 1995, Relationships of very large, deep-seated, bedrock landslides and concentrated, shallow earthquakes: Geological Society of America Abstracts with Programs, v. 27, no. 6, p. A-377.

#6260 Engebretson, D.C., Easterbrook, D.J., and Kovanen, D.J., 1996, Triggering of very large, deep-seated, bedrock landslides by concentrated, shallow earthquakes in the North Cascades, Washington: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 64.

#6263 Kovenan, D.J., 1996, Extensive late-Pleistocene alpine glaciation in the Nooksack River Valley, north Cascades, Washington: Bellingham, Western Washington University, unpublished M.S. thesis, 186 p.

#6264 Kovenan, D.J., and Easterbrook, D.J., 1996, Extensive readvance of late Pleistocene (YD?) alpine glaciers in the Nooksack River valley, 10,000 to 12,000 years ago, following retreat of the Cordilleran ice sheet, North Cascades, Washington: Friends of the Pleistocene Pacific Coast Cell, Field trip guidebook, 74 p.

#5696 Misch, P., 1966, Tectonic evolution of the northern Cascades of Washington State: Canadian Institute of Mining and Metallurgy Special Volume 8, p. 101-148.

#6266 Qamar, A.I., and Zollweg, J.E., 1990, The 1990 Deming, Washington earthquakes—A sequence of shallow thrust earthquakes in the Pacific Northwest: Eos, Transactions of the

	American Geophysical Union, v. 71, no. 41, p. 1145. #4191 Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R., 1996, Assessing earthquake hazards and reducing risk in the Pacific Northwest—Volume 1:U.S. Geological Survey Professional Paper 1560, 306 p.