INFORMATION BOOKLET

TO ACCOMPANY BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAP

	BANFF	BLAINE	BURNS LAKE	CACHE CREEK	CALGARY	CAMPBELL RIVER	CHETWYND	COURTENAY	CRANBROOK	CRESTON	DAWSON CREEK	EDMONTON	FERNIE	FORT NELSON	FORT ST. JOHN	GOLDEN	GRAND FORKS	HOPE	JASPER	KAMLOOPS	KELOWNA	KELSEY BAY	KITIMAT	MERRITT	NANAIMO	NELSON	OSOYOOS	PARKSVILLE	PENTICTON	PORT ALBERNIE	POWELL RIVER	PRINCE GEORGE	PRINCE RUPERT	PRINCETON	QUESNEL	RADIUM HOT SPRINGS	REVELSTOKE	SALMON ARM	SEATTLE	SMITHERS	SPOKANE	SQUAMISH	TERRACE	TETE JAUNE CACHE	TRAIL	VANCOUVER	VANDERHOOF	VERNON	VICTORIA	WATSON LAKE	WHITEHORSE	WILLIAMS LAKE
ASHCROFT	586	317	680	9	709	498	765	452	686	670	866	1007	765	1349	940	450	437	188	534	92	263	578	1087	107	345	575	310	379	311	426	485	458	1181	197	334	557	303	197	478	827	624	405	1032	431	543	340	551	209	372	1888	2344	214
BANFF		898	880	576	130	1096	965	1051	275	384	1066	427	357	1520	1139	136	619	768	286	498	482	1174	1298	590	946	507	605	979	544	1027	1061	656	1384	656	776	133	283	381	1022	1024	581	986	1226	387	509	920	752	429	955	2077	2501	781
BLAINE			989	322	1027	229	1074	184	843	734	1174	1210	942	1629	1248	762	499	130	840	400	438	307	1406	339	78	638	376	112	376	160	194	765	1491	264	645	866	614	517	178	1133	619	118	1334	739	610	53	861	491	72	2186	2610	526
BURNS LAKE				667	1006	1187	597	1142	1096	1205	634	962	1195	1152	771	902	1104	859	594	746	918	1266	418	779	1037	1243	981	1070	981	1118	1152	224	502	869	344	954	960	862	1142	144	1288	1077	346	493	1214	1011	128	866	1046	1709	2133	462
CACHE CREEK					706	522	752	475	688	672	853	888	787	1333	926	440	437	192	518	78	253	600	1085	112	370	576	314	403	314	451	485	443	1170	202	323	544	292	195	475	811	621	410	1013	418	547	344	539	200	379	1890	2314	205
CALGARY						1226	966	1181	405	514	866	298	323	1346	939	266	749	898	413	627	611	1304	1424	720	1075	637	734	1109	674	1157	1190	782	1510	786	902	262	413	510	1152	1150	710	1115	1352	514	638	1050	878	558	1085	1902	2326	910
CAMPBELL RIVER							1272	45	1042	933	1373	1408	1141	1827	1446	960	698	328	1038	598	635	78	1605	538	154	837	574	117	574	165	62	963	1690	462	843	1064	813	715	406	1331	848	194	1533	938	808	176	1059	688	264	2384	2808	725
CHETWYND								1227	1181	1290	101	669	1262	555	174	309	1290	944	678	830	1005	1350	950	864	1122	1328	1066	1155	1066	1203	1237	309	1099	954	429	1038	1045	947	1227	741	1373	1162	942	578	1299	1096	405	952	1131	1112	1536	547
COURTENAY									997	888	1328	1363	1096	1782	1402	915	653	283	994	554	590	123	1562	493	109	792	530	72	530	120	18	918	1646	418	798	1019	768	670	362	1288	803	149	1490	893	763	131	1014	643	219	2339	2763	680
CRANBROOK										109	1282	702	99	1736	1355	248	344	714	507	610	590	1120	1514	669	891	232	467	925	528	973	1006	872	1598	579	1010	144	395	493	747	1240	306	931	1442	603	234	866	968	541	901	2325	2749	891
CRESTON											1390	811	206	1845	1464	357	235	605	616	678	482	1011	1622	560	782	123	358	816	419	864	898	981	1707	470	995	251	504	592	677	1349	235	822	1550	714	125	757	1077	534	792	2434	2858	877
DAWSON CREEK												568	1363	480	74	1088	1290	1045	779	931	1106	1451	1051	965	1222	1429	1166	1256	1166	1304	1328	410	1136	1054	530	1139	1146	1048	1328	778	1474	1253	979	678	1400	1187	506	1051	1232	1037	1481	648
EDMONTON													621	1048	642	563	1043	1080	368	810	909	1488	1379	902	1258	934	1032	1291	971	1339	1373	738	1464	992	858	560	710	808	1363	1106	1005	1298	1307	469	933	1232	834	856	1267	1605	2029	976
FERNIE														1818	1437	320	442	813	581	690	688	1218	1595	766	990	330	565	1024	626	1072	1106	954	1698	677	1091	224	475	573	846	1339	405	1030	1541	685	331	965	1067	630	1000	2261	2685	973
FORT NELSON															406	1542	1744	1499	1234	1386	1560	1906	1506	1419	1677	1883	1621	1710	1621	1758	1792	864	1654	1509	984	1594	1600	1502	1782	1296	1928	1717	1434	1133	1854	1651	960	1533	1686	557	981	1102
FORT ST. JOHN																1162	1363	1118	853	1005	1179	1525	1125	1038	1296	1502	1240	1330	1240	1378	1411	483	1275	1128	603	1213	1219	1122	1402	851	1547	1336	1053	752	1474	1270	579	1126	1306	963	1387	722
GOLDEN																	594	632	309	362	346	1038	1320	454	810	480	469	843	408	891	925	678	1405	514	763	104	147	245	995	1046	554	850	1248	410	482	784	774	293	819	2099	2523	645
GRAND FORKS																		370	851	418	248	776	1522	325	547	139	123	581	184	629	662	880	1606	235	760	486	446	358	578	1248	206	587	1450	757	110	522	976	301	557	2301	2725	642
HOPE																			710	270	307	406	1278	210	178	509	246	211	246	259	293	635	1363	134	515	736	485	387	283	1003	554	218	1205	610	480	152	731	360	187	2056	2480	397
JASPER																				440	614	1117	1011	533	888	739	734	922	677	970	1003	374	1096	622	490	363	456	554	994	738	806	928	939	101	741	862	466	562	898	1790	2214	549
KAMLOOPS																					174	677	1163	93	448	557	294	482	237	530	563	522	1248	182	402	466	214	117	653	890	605	488	1091	339	542	422	618	122	458	1942	2366	283
KELOWNA																						715	1338	264	486	386	123	520	62	568	602	696	1421	174	576	450	198	110	530	1062	430	526	1264	514	368	461	790	53	496	2117	2541	458
KELSEY BAY																							1683	616	232	915	653	195	653	243	141	1042	1770	541	922	1142	891	794	485	1410	926	272	1611	1016	886	254	1138	766	342	2462	2886	803
KITIMAT																								1197	1454	1661	1398	1488	1398	1536	1570	642	229	1285	762	1371	1378	1280	1562	274	1706	1494	72	910	1632	1429	546	1285	1464	2062	2486	880
MERRITT																									387	464	202	421	202	469	502	555	1282	90	435	558	307	210	493	923	509	427	1125	432	435	362	651	214	397	1976	2400	317
NANAIMO																										686	424	37	424	85	54	813	1539	312	693	914	662	565	256	1181	698	46	1382	787	658	26	909	541	110	2234	2658	574
NELSON																											262	720	323	768	802	1019	1746	374	899	376	248	496	674	1387	232	726	1589	835	69	661	1115	438	696	2440	2864	781
OSOYOOS																												458	61	506	539	757	1483	112	638	582	331	234	406	1125	307	464	1326	634	234	398	853	176	434	2178	2602	518
PARKSVILLE																													458	48	90	846	1573	336	726	947	696	598	290	1214	731	77	1416	821	691	59	942	574	147	2267	2691	608
PENTICTON																														506	539	757	1483	112	638	512	261	173	467	1125	368	464	1326	573	306	398	853	115	434	2178	2602	518
PORT ALBERNIE																															138	894	1621	394	774	995	744	646	338	1262	779	125	1464	869	739	107	990	622	195	2315	2739	656
POWELL RIVER																																928	1654	427	808	1029	778	680	376	1296	813	163	1489	902	773	141	1024	656	165	2349	2773	690
PRINCE GEORGE																																	726	645	117	730	736	638	918	368	1064	853	570	269	990	787	96	643	822	1421	1845	238
PRINCE RUPERT																																		1371	846	1456	1462	1365	1645	358	1790	1579	157	995	1717	1514	630	1368	1549	2211	2635	965
PRINCETON																																			523	618	366	285	418	1013	419	352	1214	522	346	286	741	221	322	2066	2490	405
QUESNEL																																				867	616	518	798	488	944	733	690	389	870	667	216	522	702	1541	1965	118
RADIUM HOT SPRINGS																																					251	349	890	1098	450	954	1299	461	376	888	826	397	923	2150	2574	749
REVELSTOKE																																						98	768	1104	638	702	1306	554	565	637	832	146	672	2157	2581	498
SALMON ARM																																							670	1006	541	605	1208	456	467	539	734	58	574	2059	2483	400
SEATTLE																																								1286	442	296	1488	893	664	230	1014	582	250	2339	2763	680
SMITHERS																																									1432	1221	202	637	1358	1155	272	1010	1190	1853	2277	606
SPOKANE																																										738	1634	944	226	672	1160	483	691	2485	2909	826
SQUAMISH																																											1422	827	698	66	949	581	133	2274	2698	614
TERRACE																																												838	1560	1357	474	1211	1392	1990	2414	808
TETE JAUNE CACHE																																													837	762	365	459	797	1690	2114	448
TRAIL																																														632	1086	421	667	2411	2835	752
VANCOUVER																																															883	515	67	2208	2632	549
VANDERHOOF																																																738	918	1517	1941	334
VERNON																																																	549	2064	2488	405
VICTORIA																																																		2243	2667	584
WATSON LAKE																																																			424	1659
WHITEHORSE																																																				2083

DISTANCE CHART

HOW TO USE THIS CHART .

TO FIND THE DISTANCE BETWEEN CRANBROOK AND SMITHERS FIND CRANBROOK ON THE CHART AND FOLLOW THE SHADED ROW UNTILL IT INTERCEPTS THE VERTICAL ROW FROM SMITHERS. THE NUMBER IN THE BOX REPRESENTS THE APPROXIMATE DISTANCE IN KILOMETRES, IN THIS CASE IT IS 1240 km. DISTANCES OVER WATER ARE NOT INCLUDED.

DISTANCES IN KILOMETRES

CONTENTS

PLACES TO GO FOR INFORMATION

REFERENCE LIBRARIES

Victoria	University of Victoria
	Ministry of Energy, Mines and Petroleum Resources Room 430, Douglas Building 617 Government Street V8V 1X4
Vancouver	Geological Survey of Canada 5th Floor, 100 West Pender Street V6B 1R8
	University of British Columbia Department of Geological Sciences and main library

MAPS AND AIR PHOTOGRAPHS

Victoria	Ministry of Environment Map and Air Photo Sales Room 101, 553 Superior Street V8V 1X4
Ottawa	Surveys and Mapping Branch 615 Booth Street K1A 0E8

MAPS AND REPORTS

Victoria	Ministry of Energy, Mines and Petroleum Resources Basement, 552 Michigan Street V8V 1X4
	Queen's Printer Bookstore 506 Government Street V8V 4R6
Vancouver	Geological Survey of Canada 5th Floor, 100 West Pender Street V8B 1R8

CLAIM MAPS AND FREE MINER CERTIFICATES

Victoria	Ministry of Energy, Mines and Petroleum Resources Room 412, Douglas Building 617 Government Street V8V 1X4		
Mining Recorders' Offices	Port Alberni	Nanaimo	Revelstoke
	Atlin	Nelson	Princeton
	Quesnel	Vernon	Prince Rupert
	Clinton	New Westminster	Kaslo
	Cranbrook	Merritt	Rossland
	Golden	Smithers	Vancouver
	Kamloops	Pemberton	Victoria
	Lillooet		

MINING AND EXPLORATION INFORMATION

District Geologists' Offices	Ministry of Energy, Mines and Petroleum Resources:		
	Kamloops	Charlie Lake	Prince George
	Nelson	Smithers	Fernie

SELECTED BOOKS AND ARTICLES OF GEOLOGICAL INTEREST FOR BRITISH COLUMBIA

GENERAL

126 Stops of Interest in Beautiful British Columbia: David E. McGill, *Frontier Publishing Co. Ltd.,* Aldergrove, 1979.

Atlas of British Columbia: People, Environment and Resource Use: A. L. Farley, *University of British Columbia Press,* 1979.

Hotsprings of Western Canada, A Complete Guide: J. McDonald, D. Pollock, B. McDermot, *Labrador Tea Company,* Vancouver, 1978.

Natural History of the Cowichan Valley: Edited by John Simeon, *Cowichan Valley Natural History Society,* 1974.

Horne Lake Wonder Caves: Paul Griffiths, *Maquinna Publishing,* 1975.

Rock Hounding and Beachcombing on Vancouver Island: Bill and Judy Hutchinson, *The Rockhound Shop,* Victoria, 1971.

Hiking Trails on Vancouver Island, Volumes I, II and III, *Outdoor Club of Victoria Trail Booklet Publication Society.*

BOOKS OF HISTORICAL INTEREST

Ways Harsh and Wild: D. Anderson, *J. J. Douglas,* Vancouver, 1973.

The Guide to Gold Panning in British Columbia: N. L. Barlee, *Canada West Publications,* Summerland, 1972.

Gold Panner's Manual: G. Basque, *Stagecoach Publishing Co.,* Langley, 1976.

Klondike — The Last Great Gold Rush: P. Berton, *McClelland and Stewart,* Toronto, 1972.

Mining in Focus — An Illustrated History of Mining in British Columbia: B. Ramsay, *Agency Press Ltd.,* Vancouver, 1968.

Mining: The History of Mining in British Columbia: W. A. Taylor, *Hancock House,* Saanichton, 1978.

Fur, Gold and Opals — A Guide to the Thompson River Valley: M. Shewchuk, *Hancock House,* Saanichton, 1975.

The Town That Got Lost, A Story of Anyox, B.C.: P. Louden, *Grays Publishing Co.,* Sidney, 1973.

Britannia: The Story of a Mine: B. Ramsay, *Britannia Beach Community Club,* Britannia Beach, 1967.

Historic Treasures and Lost Mines: N. L. Barlee, *Canada West Publications,* Summerland, 1977.

Gold Creeks and Ghost Towns: N. L. Barlee, *Canada West Publications,* Summerland, 1970.

Barkerville Days: A. W. Ludditt, *Mitchell Press,* Vancouver, 1969.

Barkerville, Quesnel, and the Cariboo Gold Rush: G. R. Elliott, *Douglas and McIntyre,* Vancouver, 1958.

And So That's How It Happened — Recollections of Stanley-Barkerville 1900-1975: W. M. Hong, *W. M. Hong,* Wells, 1978.

Barkerville: A Guide to the Fabulous Cariboo Gold Camp: B. Ramsay, *Sononis Publishers,* 1968.

ADVENTURES IN EARTH SCIENCE SERIES

— available from the University of British Columbia bookstore,
2075 Westbrook Mall, Vancouver

Number 3: Historical Geology of the Lower Fraser Valley, R. H. Blunden.

Number 9: Victoria-Saanich Geology, J. L. Rau.

Number 11: Geology of Kamloops, A Guide for Teachers, D. Rolston.

Number 15: Urban Geology of Richmond, British Columbia, R. H. Blunden.

SELECTED BOOKS AND ARTICLES OF GEOLOGICAL INTEREST FOR BRITISH COLUMBIA

NATIONAL PARKS GUIDEBOOKS

A Guide to Geology for Visitors to Canada's National Parks, Revised Edition: D. M. Baird, *McMillan*, Toronto, 1974.

Banff National Park: D. M. Baird, *Hurtig Publishers*, 1977.

Jasper National Park: D. M. Baird, *Hurtig Publishers*, 1977.

Geology of the Canadian National Parks on the Canadian Pacific Railway between Calgary and Revelstoke: C. Camsell, *Department of the Interior*, Ottawa, 1914.

PROVINCIAL PARKS GUIDEBOOKS

Exploring Garibaldi Park, Volume I: D. Bowers and B. Epting, *J. J. Douglas*, Vancouver, 1977.

Exploring Garibaldi Park, Volume II: D. Bowers, *J. J. Douglas*, Vancouver, 1977.

Exploring Manning Park: A. Harcombe, R. Cyca, *J. J. Douglas*, Vancouver, 1979.

Exploring Golden Ears Park: D. Bowers, *J. J. Douglas*, Vancouver, 1976.

Exploring the Southern Okanagan and Cathedral Provincial Park: D. Bowers, *J. J. Douglas*, Vancouver, 1976.

POPULAR GUIDEBOOKS (Published by the Cordilleran Section, Geological Association of Canada)

Garibaldi Geology, A Popular Guide to the Geology of the Garibaldi Lake Area: W. H. Mathews, 1975.

Vancouver Geology – A Short Guide: G. H. Eisbacher, 1973.

BRITISH COLUMBIA MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

– available at Publications outlet, 552 Michigan Street (Basement), Victoria, B.C.

Notes on Placer Mining in British Columbia: Bulletin 21, 1959.

Landforms of British Columbia, A Physiographic Outline: Bulletin 48, by Stuart S. Holland, 1964.

Jade in British Columbia: *in* Annual Report, 1962, pages 119 to 126, by Stuart S. Holland.

Elementary Geology Applied to Prospecting, Fifth Edition: by J. F. Walker, 1970.

The Identification of Common Rocks: by Officers of the Department, 1970.

GEOLOGICAL SURVEY OF CANADA

– reports and maps available at Geological Survey of Canada's office in Vancouver, 5th Floor, 100 West Pender Street, Vancouver, B.C.

GENERAL

Miscellaneous Reports: D. M. Baird

- Number 4: Yoho National Park, 1962.
- Number 6: Jasper National Park, 1963.
- Number 9: Kootenay National Park, 1964.
- Number 10: Waterton Lakes National Park, 1964.
- Number 11: Glacier and Mount Revelstoke National Parks, 1965.

Miscellaneous Report Number 8: Rocks and Mineral Collecting in Canada, Ann P. Sabina.

Pacific Rim National Park: A. H. Lang and J. E. Muller, 1975.

BRITISH COLUMBIA MUSEUMS WITH DISPLAYS OF GEOLOGICAL OR MINING INTEREST

NOTE: All telephone numbers have area code 604.
Hours quoted are subject to change for smaller museums.

ASHCROFT		
Ashcroft Museum c/o 409 Bancroft St. Drawer 129 Phone: 453-9232	Mining and mineralogy displays.	Starting June 1, 10-5 daily, Monday-Saturday
ATLIN		
Atlin Museum Box 111 Phone: Atlin 111	Gold rush material, natural history, and Indian artifacts.	June-September, 1-4 daily
BARKERVILLE		
Barkerville Historic Park Phone: 994-3209	Cariboo gold rush history. Mining technology, small gold rush research library. *Summer only there are live stage shows, stage coach rides, gold panning, and other attractions.	Summer*: daily Town: 8-8 Museum: 9-5 Winter: daily Both: 8-4
BLACK CREEK		
Miracle Beach Provincial Park Nature House Vancouver Island Phone: 337-5441	Natural history displays.	June 15-30. 1-5 daily July 1 - Labour Day, 10-9 daily
BRITANNIA BEACH		
British Columbia Museum of Mining Box 155 Phone: 688-8735 or 896-2233	Mining museum, underground train tours at the site of the former Britannia copper mine to see live demonstrations of underground mining, mill tour, gold panning, history trail.	7 days a week, early May-Larbour Day, 9:30-6:45 daily September: weekends April 1 - December 8, pre-booked tours
CHASE		
Shuswap Lake Provincial Park Nature House Phone: 955-2217	Natural history displays.	Summer: 11-9
COURTENAY		
Courtenay and District Museum Box 3128 Phone: 338-2330	Small fossil collection.	May 24-Labour Day weekend 1-5 daily Closed in winter
CUMBERLAND		
Cumberland Museum Box 258 Phone: 336-2445	Pioneer artifacts, coal mining relics, Chinese items.	September-June, Monday-Friday, 1-5 July-August, 9-5 daily
DAWSON CREEK		
Dawson Creek Museum Art Gallery 13th St. and Alaska Ave. Phone: 782-4868	Fossil displays, including a mammoth tusk; personnel knowledgeable about the region.	Summer: 9-9 daily Winter: 9-5 weekdays
FERNIE		
Fernie Museum Box 1527 Phone: 423-7016	Coal mining equipment is set up outside the museum and coal mining equipment is displayed in a simulated mine tunnel in the basement. The main exhibits, enriched by many photographs, are about the life styles of the early coal miners.	1:30-5:30 daily Tours by appointment

FORT ST. JOHN		
Peace Island Park Museum (Museum at Taylor, 12 miles south of Fort St. John) Phone: 789-3615	Fossils, rocks, and shell displays.	May-October 15, 10-8 daily
GRAND FORKS		
Boundary Museum Box 17 108 South East Ninth St. Phone: 445-6385	Mining and logging equipment and photographs.	June 15-September 15, 10-8 daily By appointment in winter
HUDSON'S HOPE		
Hudson's Hope Museum Box 98 Phone: 783-5735	Fossils and archaeological displays, near Bennett Dam. Displays relate to dinosaurs, gold panning, and coal mining.	May 24-September 12, 9:30-5:30
HYDRO SITE 1		
Dam Exhibit Centre Peace Canyon Power Project, Box 509, Highway 29 west of Hudson's Hope Phone: 663-2419	The history and prehistory of the Peace River area is featured. Displays include models of hydrosaur dinosaurs, casts of dinosaur and early bird footprints, geological maps and photographs.	An open display Daylight hours
KAMLOOPS		
Kamloops Museum 207 Seymour St. Phone: 372-9931	Natural history and geology of Thompson River area.	Mid-June-Labour Day Monday-Friday, 10-9 Saturday, 10-5 Winter: Monday-Friday, 3-5 and 7-9 Saturday, 10-5
KELOWNA		
Kelowna Centennial Museum and National Exhibit Centre 470 Queenway Phone: 763-2417	Fossils, interior Salish Indian artifacts. The curator, Ursula Surtees, is very knowledgeable about the area.	Summer: 10-8:30 daily Winter: 10-5 daily
KITIMAT		
Kitimat Smelter	The smelter gives guided tours daily.	Summer: Monday-Saturday, 12-5
Kitimat Centennial Museum 293 City Centre Phone: 632-7022	Indian artifacts, natural history, and fossil displays.	Winter: Tuesday-Saturday, 3-5
LILLOOET		
Lillooet Museum Box 441 Main St. Phone: 256-4308	Some mining and gold rush exploration displays.	May Day-June 30 and September 1-October 31, 1-4 daily June 1-August 31, 9:30-5:30 daily
MANNING PARK		
Manning Provincial Park Nature House Phone: 840-8836 or 840-8833	Natural history displays.	June 1-Labour Day, till dusk Closed in winter

MISSION *Mission Museum* 33201 Second Ave. Phone: 826-1011 or 826-8808	Mineral collection.	Summer: Wednesday-Sunday, 2-4 Winter: Friday-Sunday, 2-4 or by appointment
NANAIMO *The Bastion* Phone: 753-6044	Some mining information.	May 24-Labour Day, Monday-Saturday, 10-5 or by appointment
Nanaimo Centennial Museum 100 Cameron Rd. Phone: 753-1821	Coal mining history, simulated mine tunnel, knowledgeable personnel.	May 1-September 1, 10-5 daily Winter: Monday-Friday, 12-4
NELSON *Nelson Centennial Museum* 402 Anderson Phone: 352-9813	Geology and mining history. The curator, Bernie Fetterley, is knowledgeable about the area.	Year round by appointment May-October, weekends July-August, daily, 12 noon - 8
NORTH VANCOUVER *Lynn Canyon Ecology Centre* 3663 Park Rd. Phone: 987-5922	Ecological multi-media displays.	Summer: 10-8 daily Winter: 10-5 daily
OSOYOOS *Osoyoos Museum* Box 791 Phone: 495-6723	Mining and ore samples, fossils, natural history.	May 1-September 15, 10-5:30 daily
PENTICTON *R. N. Atkinson Museum* 785 Main St. Phone: 492-6025	Mineralogy and excellent natural history displays. The curator, Joe Harris, is knowledgeable about the area.	June 15-September 15, 1-9 daily Winter: Monday-Saturday, 1-5 Closed Sunday
POWELL RIVER *Powell River Historical Museum* Box 42 Phone: 485-2222	Collection of sands from around the world (several hundred in well-labelled pill bottles).	By arrangement
PRINCE GEORGE *Fort George Regional Museum* Box 1779 Phone: 562-1612	Although there is little of geological interest at the museum now (1982), it is a major museum and undoubtedly will acquire displays in the future. The personnel are also a good source of information and contacts.	Daily, 1-5, except Monday and Tuesday
PRINCE RUPERT *Museum of Northern British Columbia* Box 669 McBride at First Ave. Phone: 624-5637	Small rock collection, natural and modern history, ethnology.	May 15-August 31, 9-9 daily September 1-May 15, Monday-Saturday, 9-4

QUESNEL		
Quesnel Historical Museum Le Bourdais Park 405 Barlow Ave. Phone: 992-9580	Rock and mining displays, enroute to Barkerville. The curator, Sheila Hill, is knowledgeable about the area.	May 1-October 15, 9-8
RED PASS		
Mount Robson Provincial Park Nature House Phone: 566-4325	Natural history displays.	June 16-Labour Day, 8:45-3:45 daily Guided walks, 9 a.m. daily Evening talks, 8 p.m. daily Closed in winter
ROSSLAND		
Rossland Historical Museum Box 26 Junction Highways 22 and 38 Phone: 362-7722	Underground tour of LeRoy mine, displays, knowledgeable personnel.	Mid-May- mid-September, 9:30-5 daily
SANDON		
Sandon Museum Box 303 New Denver	Road access is poor but has an interesting display about the early life of this mining town with both photographs and equipment. New Denver Museum is nearby and has an interpretive mining exhibit.	
SMITHERS		
Bulkley Valley Historical and Museum Society Box 2615 Phone: 847-3898	Some fossil material.	May-September, 9-12, 1-6 daily September-May, 1-4, Tuesday-Saturday
WELLS		
Wells Historical Society Box 244 Phone: 994-3379 or 994-3248	Local placer and hard-rock mining history.	June-September
WILLIAMS LAKE		
Williams Lake Museum Phone: 392-4158	Local mining history.	May-August, 9-9 daily
VANCOUVER		
M. Y. Williams Geological Museum Geological Sciences University of British Columbia Phone: 228-5586	Extensive exhibits of rocks, minerals, and fossils including a complete dinosaur and models of plate tectonics and mining techniques. The curator, Joe Nagel, is very knowledgeable.	Weekdays: 9-4:30
VICTORIA		
British Columbia Provincial Archives Parliament Buildings Phone: 387-3621	Manuscripts, records, books, pamphlets, maps, paintings, sound recordings, and photographs relating to British Columbia history. Operates as a reference institution, material noncirculating.	Weekdays: 9-5:30
Geological Branch *Ministry of Energy, Mines and Petroleum Resources* 4th Floor, Douglas Building Phone: 387-5975	Rock and mineral displays, other temporary displays, extensive reference library.	Weekdays: 8:30-4:30 (Library is closed 12 noon - 1)
British Columbia Provincial Museum 601 Belleville St. Phone: 387-3701	Superb natural history exhibits.	April 1-September 30, 10-7:30 daily October 1-March 31, 10-5:30 daily

The assistance of Greg Evans and John Adams, Provincial Museum advisors, is gratefully acknowledged.

GEM HUNTING – 1982

Information regarding gem hunting in British Columbia can be obtained from these sources:

British Columbia Faceters Guild
3085 Adanac Street
Vancouver V5K 2N6

Buckley Valley Mineral and Lapidary Club
Attention: Mrs. Myrna Briggs
RR 1, Virginia Street
Smithers V0J 2N0

Burnaby Gem and Mineral Club
Box 80741
South Burnaby V5H 3X6

Burnaby Laphounds Club
Box 80164, 6025 Sussex Street
Burnaby V5H 3X5

Chilliwack Lapidary Club
Box 322
Chilliwack V2P 6J4

Cowichan Valley Rockhound Club
Box 232
Duncan V9L 3X3

Creston Valley Rock and Mineral Club
Attention: Hilda Kilgren, Secretary
RR 1
Creston V0B 1G0

Delta Rockhounds
Attention: Mrs. Nancy Dawson
4732 – 46th Avenue
Delta V4K 1N2

Dunbar Lapidary Club
4747 Dunbar Street
Vancouver V6S 2H2

Fraser Valley Rock and Gem Club
Box 513
Aldergrove V0X 1A0

Gem-N-1 Craftsmen
19625 Lougheed Highway
Pitt Meadows V0M 1P0

Golden Rockhounds
Box 536
Golden V0A 1H0

Greenwood Rock and Antique Club
Box 243
Greenwood V0H 1J0

Hastings Centre Rockhounds
Hastings Community Centre
3096 East Hastings Street
Vancouver V5K 2A3

Houston Rockhound Club
Box 828
Houston V0J 1Z0

Kokanee Rock Club
707 Radio Avenue
Nelson V1L 3L2

Lapidary Club of Vancouver
Box 145, Station A
Vancouver V6V 2M3

Lapidary Club of West Vancouver
1555 Rena Crescent
West Vancouver V7V 2Z2

Lapidary Rock and Mineral Society of British Columbia
Attention: Mrs. C. Sparkes, Executive Secretary
941 Wavertree Road North
North Vancouver V7R 1S4

Lillooet Rock and Gem Club
Box 633
Lillooet V0K 1V0

Maple Ridge Lapidary Club
Box 142
Maple Ridge V2X 7E9

Mile O Jade and Rock Club
Attention: W. S. Bouvette
Box 55
Lillooet V0K 1V0

GEM HUNTING – 1982 *(CONTINUED)*

Mission Valley Rock and Mineral Club
33580 Fifth Avenue
Mission City V2V 1H4

Nechako Valley Rock Club
Rolling Stone Rock Shop
General Delivery
Engen V0J 1M0

New Westminster Lapidary Club
49 Sixth Street
New Westminster V3L 2Z2

Nicola Valley Rockhounds
Box 61
Lower Nicola V0K 1Y0

North Shore Rock and Gem Club
Box 236
North Vancouver V7L 4S8

1120 Rock Club
Box 182
Kelowna V1Y 7N5

Penticton Geology and Lapidary Club
Box 132
Penticton V2A 6J9

Port Moody Rock and Gem Club
300 Ioco Road
Port Coquitlam V3H 2V7

Powell River Lapidary Club
5770 Hatfield Place
Powell River V8A 4G4

Prince Rupert Lapidary Club
1000 McBride Street
Prince Rupert V8J 3H2

Princeton Rock and Mineral Club
Box 1518
Princeton V0X 1W0

Quesnel Rock Club (1974)
Box 6, Plywood Hill, RR 1
Quesnel V2J 3H5

Richmond Gem and Mineral Club
Arts Centre, 767 Mindru Gate
Richmond V6Y 1R8

Rockcrafters Guild of North Vancouver
3436 Mount Seymour Parkway
North Vancouver V7H 1G4

Shuswap Rock Club
Box 90
Chase V0E 1M9

Similkameen Rock Club
Attention: Mrs. J. Sanders
Hedley V0X 1K0

Skyline Rock and Mineral Club
855 Park Avenue
Nanaimo V9R 4H9

Spruce City Rock and Gem Club
Box 2058
Prince George V8J 3T9

Sunshine Coast Lapidary and Crafts
Attention: J. Chappell
Route 1
Gibsons V0N 1V0

Surrey Rockhound Club
Box 355
Surrey V3T 5B6

Terrace Lapidary Club
Box 152
Terrace V8G 4A6

Thompson Valley Rock Club
Box 443
Kamloops V2C 5L2

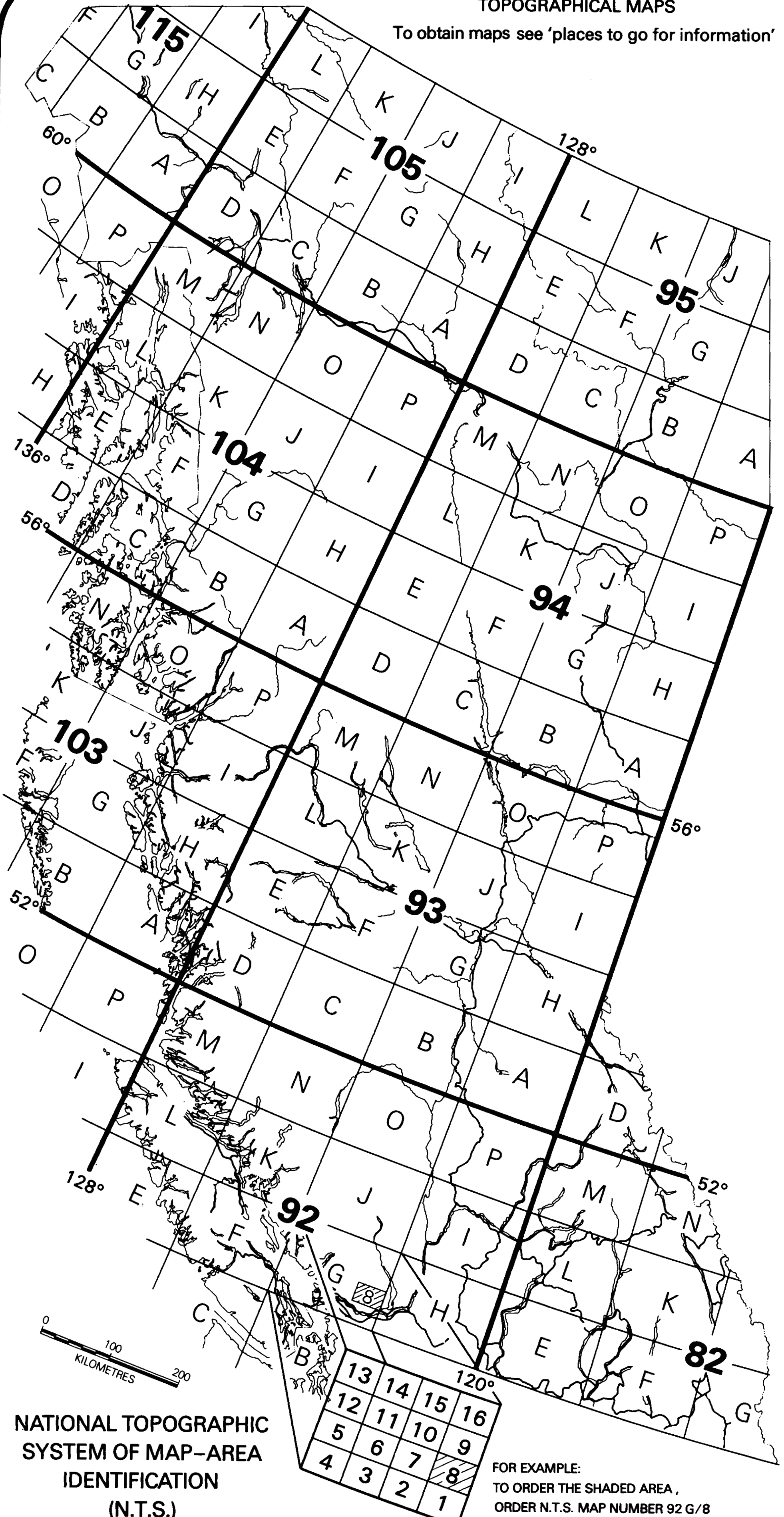
Vernon Lapidary and Mineral Club, The
Box 14
Vernon V1T 6M1

Victoria Lapidary and Mineral Society
Box 5114, Station B
Victoria V8R 6N3

Gem Hunting Information compiled by:
The Ministry of Tourism and Small Business Development
Tourism British Columbia
1117 Wharf Street
Victoria, B.C.
V8W 2Z2

TOPOGRAPHICAL MAPS

To obtain maps see 'places to go for information'



NATIONAL TOPOGRAPHIC SYSTEM OF MAP-AREA IDENTIFICATION (N.T.S.)

FOR EXAMPLE:
TO ORDER THE SHADED AREA,
ORDER N.T.S. MAP NUMBER 92 G/8

NOTES

NOTES

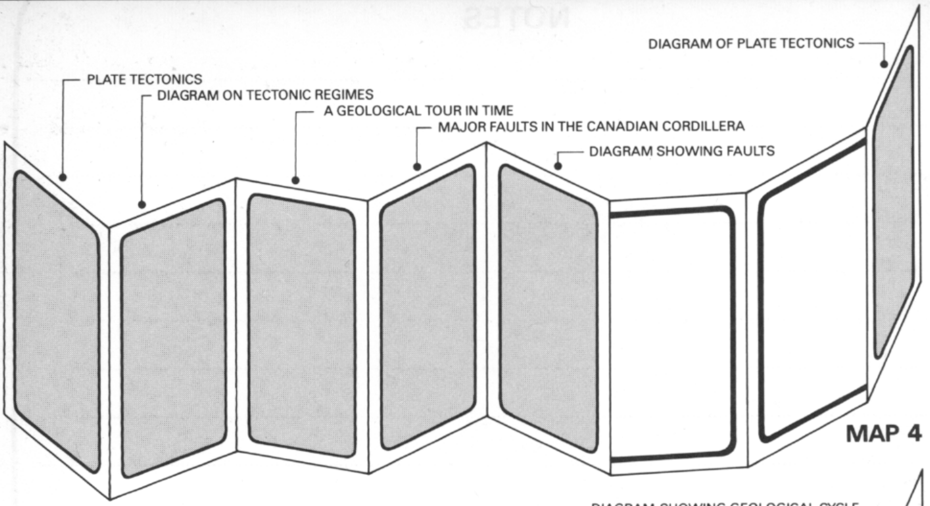


DIAGRAM OF PLATE TECTONICS
PLATE TECTONICS
DIAGRAM ON TECTONIC REGIMES
A GEOLOGICAL TOUR IN TIME
MAJOR FAULTS IN THE CANADIAN CORDILLERA
DIAGRAM SHOWING FAULTS
MAP 4

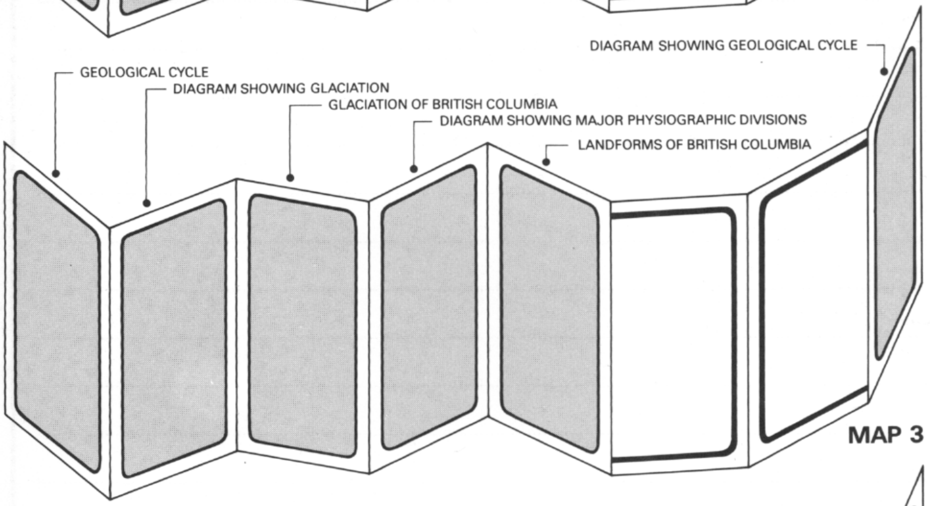


DIAGRAM SHOWING GEOLOGICAL CYCLE
GEOLOGICAL CYCLE
DIAGRAM SHOWING GLACIATION
GLACIATION OF BRITISH COLUMBIA
DIAGRAM SHOWING MAJOR PHYSIOGRAPHIC DIVISIONS
LANDFORMS OF BRITISH COLUMBIA
MAP 3

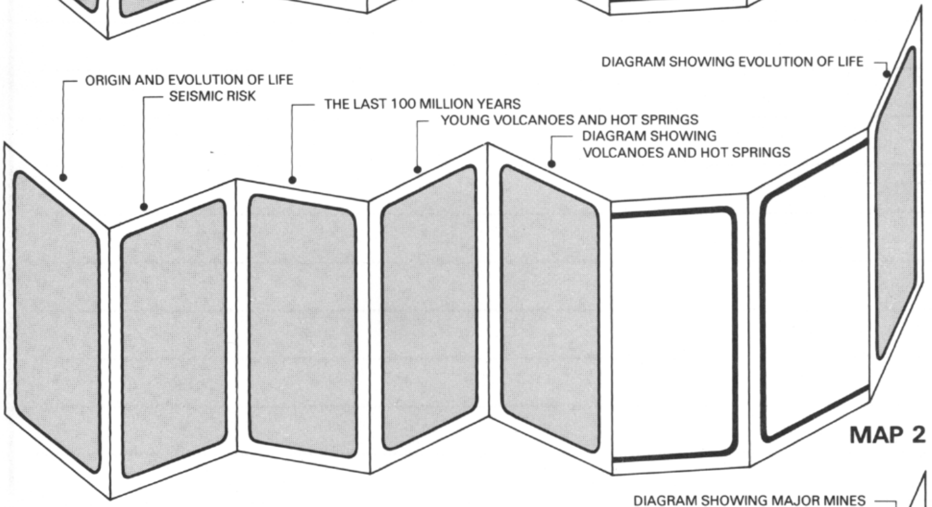


DIAGRAM SHOWING EVOLUTION OF LIFE
ORIGIN AND EVOLUTION OF LIFE
SEISMIC RISK
THE LAST 100 MILLION YEARS
YOUNG VOLCANOES AND HOT SPRINGS
DIAGRAM SHOWING
VOLCANOES AND HOT SPRINGS
MAP 2

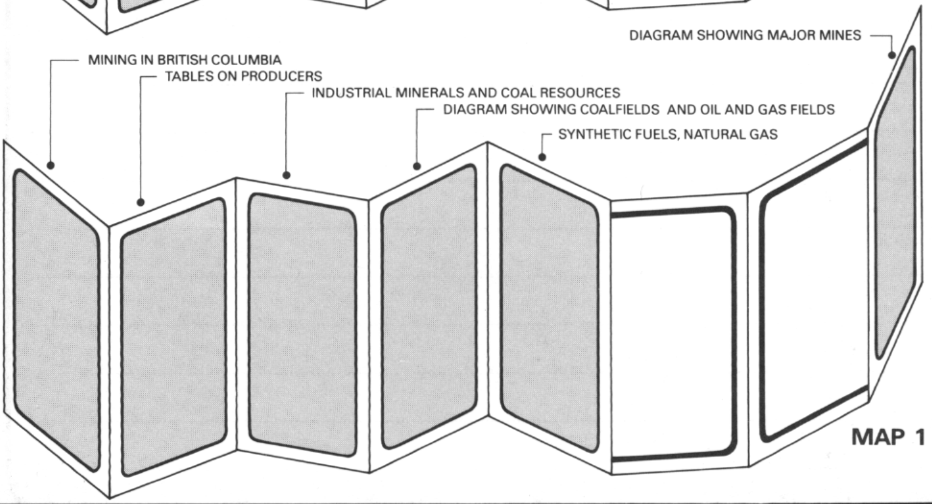


DIAGRAM SHOWING MAJOR MINES
MINING IN BRITISH COLUMBIA
TABLES ON PRODUCERS
INDUSTRIAL MINERALS AND COAL RESOURCES
DIAGRAM SHOWING COALFIELDS AND OIL AND GAS FIELDS
SYNTHETIC FUELS, NATURAL GAS
MAP 1

MINING IN BRITISH COLUMBIA

The gold rush in British Columbia followed those in California and the Klondike. Although Indians discovered gold in the Queen Charlotte Islands in 1850, pickings were slim and the Indians hostile, so little activity resulted. Thompson River gold was recovered and sold by the Indians beginning in 1852. For five years no outsiders were involved. But, in 1858, the first trickles of the forthcoming flood of gold seekers arrived when 75 Americans set up mining operations at Hills Bar below Yale.

The social impact of the arrival of these hordes of miners, prospectors, and hangers-on must have been incredible. Imagine the problems for the local people when the population of Victoria went from 225 to 450 in one day and had swelled to 5 000 a month later. In all, 25 000 people passed through Victoria during the summer of 1858.

Too often ill-equipped and ignorant, these men were ill-prepared for getting to the mainland, let alone trekking 200 miles inland to the goldfields. Thousands died enroute. They drowned trying to cross to the mainland on rafts, they starved, they were killed in accidents.

Lawlessness, so important in the California rush, was not a major problem. Sir James Douglas claimed ownership of all the gold in the name of the Crown, set up a system of miners' licences, and enforced the law. Under the system, a single miner's claim was up to 12 feet by 12 feet in size or 144 square feet; as many as four miners could pool their holdings for a maximum size of 576 square feet. The holding fee was 10 shillings a month per claim.

The gold rush was founded on fact and fueled by fiction. In fact, the take from many claims on Hills Bar averaged 50 ounces a day and three partners recovered 46 pounds of gold from their claim. Rumour had it that everyone was having similar luck!

By 1860, the search reached the famous Cariboo gold creeks in what is now the Barkerville area. The price of gold then was about $20.00 per ounce; one claim yielded returns of $100 000.00 in gold in three months.

Discoveries were made in the Stikine in 1862, the Kootenays and Leech River in 1864, Big Bend in 1866, Peace–Omineca in 1869, and finally the Cassiar district in 1872. No new goldfields were found between 1878 and 1900 and the rush petered out.

To ease access problems, the Royal Engineers set up communications systems, laid out trails and roads, and, in an extraordinary feat, built the Cariboo wagon road through Fraser Canyon.

Most of the early gold seekers who came to our shores left again when the tides of gold mining fortune ebbed. But, in their stead they left a thriving business community, roads, and a well-developed system of trails and communication networks in the interior of the province. Most of the miners were drifters but they helped develop the province.

Spin-offs from gold mining also included cattle ranching, salmon canneries, many businesses, and sawmills and logging. The miners needed food, hardware, housing, and, of course, entertainment, so saloons and hotels thrived.

Coal became the most important mining commodity about 1890; silver and lead gained importance during the 1890's. Copper began to be important in the early 1900's.

Aside from the economic impact on port cities, many communities in British Columbia are founded on mining activities – for example, Yale, Barkerville, Atlin, and many others on placer mining; Nelson on silver mining; Rossland on copper-gold mining; Kimberley on the famous Sullivan lead-zinc mine; Trail on smelting; Kaslo, Sandon, Riondel, and others on lead-silver mining in the Kootenays; and Greenwood, Britannia, and Anyox on copper mining. More recently, Endako was founded on molybdenum mining and Logan Lake on copper-molybdenum mining. Nanaimo, Comox, and Cumberland on Vancouver Island were founded on coal mining. The Fernie area relies on coal mining now and the Northeast Coalfield near Fort St. John will be a mainstay of that area.

Today the scene has shifted dramatically. The old timers struggled and died to get into the interior; we drive there on black-topped highways. Mining operations too are very different today; you can't mine 90 000 tonnes of ore a day and move 100 000 tonnes of waste with a pick and shovel. It now takes hundreds of millions of dollars to put a large open-pit mine into production, not just a willingness to work.

A survey of operating mines in 1981 highlights the new look of mining and its cyclic nature. Several new mines were opened. One, Highmont, is a copper-molybdenum open-pit deposit, but Scottie Gold Mines, Carolin Mines, and DuPont (Baker mine) are all underground gold deposits. Dramatic increases in price revitalized gold exploration; it even got some of the old placer operations going again!

But, the prospector and entrepreneur still have a role to play. In spite of all the sophisticated techniques used in exploration, new mineral showings are still being turned up by prospectors. The province is huge; the undiscovered potential is vast. Black box technology cannot yet replace two feet, sweat, a rock hammer, practical know-how, and a dream as mine-finding tools.

MAJOR METAL PRODUCERS, 1981

Mine (Name of Company)	Mine Address	Type	Ore Shipped or Treated *tonnes*	Products
Afton (Afton Mines Ltd.)	Box 937, Kamloops	O	2 324 000	Cu, Au, Ag
Baker (DuPont of Canada Ltd.)	Chappelle Creek	U	18 000	Ag, Au
Bell (Noranda Mines Ltd.)	Box 1000, Granisle	O	5 430 000	Cu, Ag, Au
Bethlehem (Bethlehem Copper Corp.)	Box 520, Ashcroft	O	6 496 000	Cu, Mo, Ag, Au
Boss Mountain (Noranda Mines Ltd.)	Hendrix Lake	O	468 000	Mo
Brenda (Brenda Mines Ltd.)	Box 420, Peachland	O	10 199 000	Cu, Mo, Ag, Au
Copper Mtn. (Newmont Mines Ltd.)	Box 520, Peachland	O	6 869 000	Cu, Ag, Au
Endako (Placer Development Ltd.)	Endako	O	10 492 000	Mo
Equity (Equity Silver Mines Ltd.)	Box 1450, Houston	O	1 910 000	Ag, Au, Cu
Erickson (Erickson Gold Mining Corp.)	Cassiar	U	38 000	Au
Gibraltar (Gibraltar Mines Ltd.)	Box 130, McLeese Lake	O	13 258 000	Cu, Mo, Ag
Granduc (Canada Wide Mines Ltd.)	Box 190, Stewart	U	614 000	Cu, Ag, Au
Granisle (Noranda Mines Ltd.)	Box 1000, Granisle	O	3 383 000	Cu, Ag, Au
Hanna (United Hearne Resources Ltd.; Taurus Resources Ltd.)	Cassiar	U	14 000 (between August 1981 and July 1982)	Au
Highland Bell (Teck Corp.)	Beaverdell	U	36 000	Ag, Pb, Zn, Au
Highmont (Teck Corp.)	Box 3000, Logan Lake	O	6 398 000	Cu, Mo
Island Copper (Utah Mines Ltd.)	Box 370, Port Hardy	O	14 157 000	Cu, Mo, Ag, Au
Kitsault (Amax of Canada Ltd.)	Box 1000, Kitsault	O	1 841 000	Mo
Lornex (Lornex Mining Corp. Ltd.)	Box 1500, Logan Lake	O	20 739 000	Cu, Mo, Ag
Lynx, Myra (Westmin Resources Ltd.)	Box 8000, Campbell River	U	246 000	Cu, Ag, Au, Zn, Pb
Mosquito Creek (Mosquito Creek Gold Mining Co. Ltd.)	Box 10, Wells	U	21 000	Au, Ag
Scottie (Scottie Gold Mines Ltd.)	Stewart	U	7 000	Au, Ag
Silvana (Dickenson Mines Ltd.)	Box 189, New Denver	U	28 000	Ag, Pb, Zn
Sullivan (Cominco Ltd.)	Box 2000, Kimberley	U	2 210 000	Pb, Zn, Ag
Tasu (Falconbridge Nickel Mines Ltd., (Wesfrob Mining Division)	Tasu	U	1 032 000	Fe, Cu, Ag, Au
Warman (Northair Mines Ltd.)	Squamish	U	62 000	Au, Ag, Pb, Zn, Cu

INDUSTRIAL MINERAL AND STRUCTURAL MATERIAL MINES AND QUARRIES, 1981

Name (Company)	Mine Address	Type	Production *tonnes*	Commodity
Cassiar (Brinco Mining Ltd.)	Cassiar	O	90 000	asbestos
Cry Lake (Cry Lake Jade Mines Ltd.)	Cry Lake	O	13 000*	jade
Domtar Texada (Domtar Inc.)	Blubber Bay	O	541 000	limestone
Lafarge (Canada Cement Lafarge Ltd.)	Kamloops	O	600 000	limestone
	Vananda	O	750 000	limestone
Mt. Moberly (Mountain Minerals Ltd.)	Golden	O	29 000	silica
Ideal Texada (Ideal Basic Industries)	Box 99, Vananda	O	1 319 000	limestone
Jade World (J. H. Bell)	Ogden Mountain	O	45 000*	jade
Windermere (Westroc Industries Ltd.)	Windermere	O	684 924	gypsum

*kilograms

MAJOR COAL PRODUCERS, 1981

Mine(s) (Company)	Mine Address	Type	Production Metallurgical *tonnes*	Production Thermal *tonnes*
Southeast Coalfield				
Harmer	Box 2000,	O		
Panel 6 (B.C. Coal Ltd.)	Sparwood	U	7 101 000	404 000
Balmer North		U		
Fording (Fording Coal Ltd.)	Box 100, Elkford	O	3 721 000	
Corbin (Byron Creek Collieries Ltd.)	Box 270, Blairmore, Alta.	O		441 000

MINES UNDER CONSTRUCTION

Mine(s) (Company)	Mine Address	Type	Capacity Metallurgical	Capacity Thermal
Southeast Coalfield				
Fording Expansion (Fording Coal Ltd.)	Box 100, Elkford	O	2 000 000	200 000
Greenhills (B.C. Coal Ltd.)	1176 W. Georgia St., Vancouver	O	1 800 000	
Line Creek (Shell Canada Resources Ltd.)	Box 100, Calgary, Alta.	O	1 300 000	1 400 000
Northeast Coalfield				
Quintette (Denison Mines Ltd.)	650 W. Georgia St., Vancouver	O	5 000 000	1 000 000
Bullmoose (Teck Corp., Lornex Mining Corp., Misshoiwai Ltd.)	1199 W. Hastings St., Vancouver	O	7 000 000	
Vancouver Island				
Quinsam (Weldwood of Canada Ltd., Brinco Mining Ltd.)	1055 W. Hastings St., Vancouver	O/U		900 000

NOTE: O = open pit; U = underground

INDUSTRIAL MINERALS AND STRUCTURAL MATERIALS

Besides metals and fuels, cement, sand and gravel, and industrial minerals are produced in British Columbia (*see* table).

British Columbia doesn't produce all industrial minerals but the value of those produced is impressive.

About 50 million tonnes of construction aggregate is produced each year from 250 pits and quarries.

Five million tonnes of limestone was quarried in British Columbia in 1981 to make lime and cement. And although asbestos, barite, diatomite, silica, ceramic and refractory clays, dolomite, magnesite, and gypsum were not produced in such large quantities, their value was many millions of dollars.

Altogether, revenues from industrial minerals and structural materials produced in our province in 1981 were more than $350 million. That's about 10 per cent of the combined value of mineral, coal, petroleum, and natural gas production. The number of industrial minerals produced in British Columbia and their industrial uses are steadily increasing. In the past few years we have added production of glass-grade silica sand and magnesite, and exploration and trial shipments have been made on deposits of mica, talc, and fluorspar.

Prospecting activity for industrial minerals is increasing and their future looks bright.

COAL RESOURCES OF BRITISH COLUMBIA

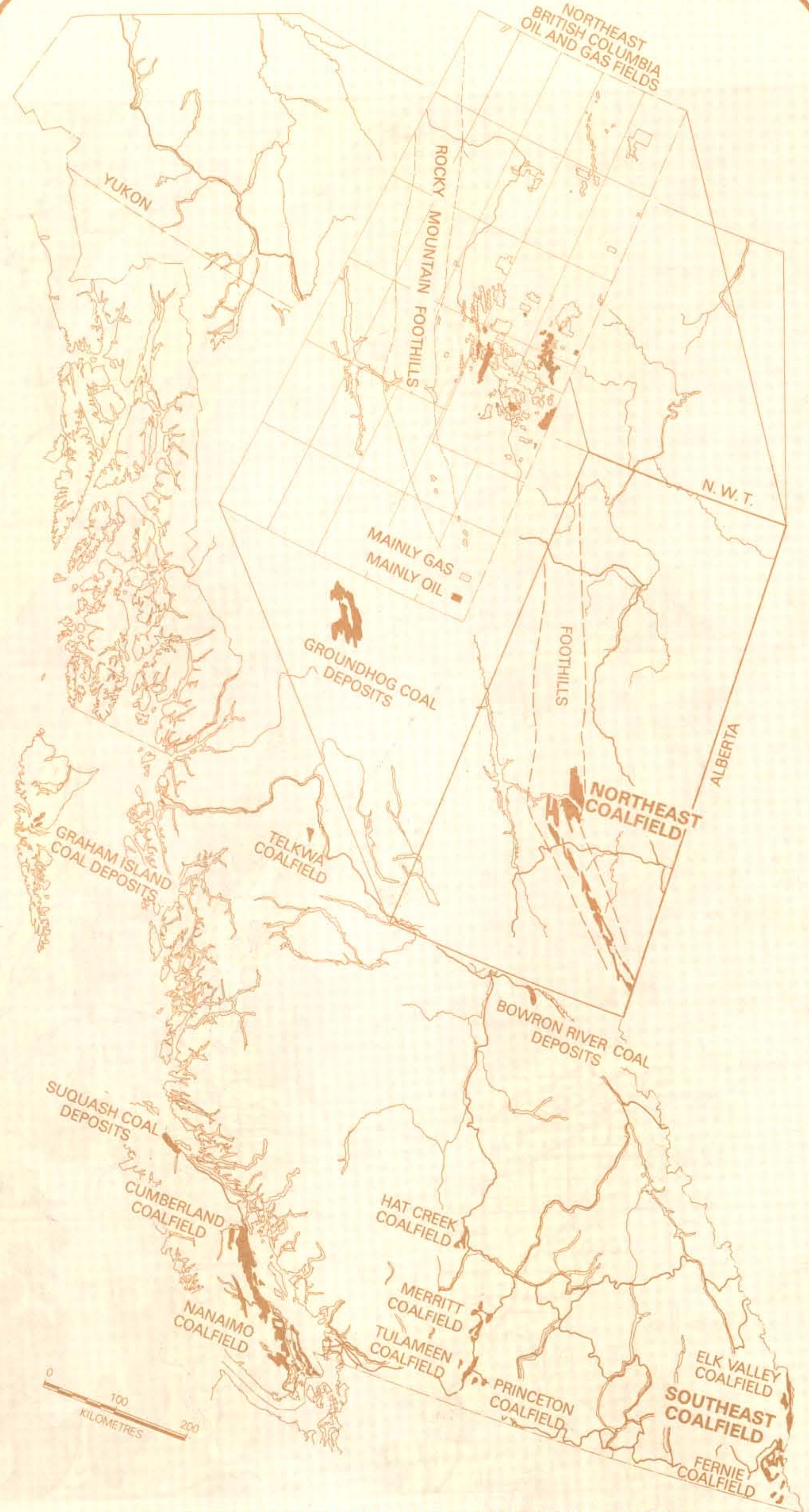
Coal fueled the Industrial Revolution. It was used mainly to generate steam and to make coke for producing pig iron. The Industrial Revolution arrived in North America in the 1860's, when 18 million tonnes of coal were used each year. By 1910 annual consumption was 450 million tonnes and in 1910 coal accounted for 90 per cent of North America's energy use. By 1950 it was down to 50 per cent and by 1972 it was only 17 per cent. The changes, however, reflect a huge increase in the amount of oil and gas consumed, not a decrease in the amount of coal used. Right now most coal is either burned for power or used to make coke; future potential uses, especially in the chemical industry, are many.

On Figure 2 you can see the areas where coal-bearing rocks occur in British Columbia. The earliest coal mining took place in the Nanaimo–Ladysmith area on Vancouver Island where 64 million tonnes of thermal coal was mined between 1849 and 1914. Mining in the East Kootenay district in the southeast part of the Province began in about 1900, first at Coal Creek, then at Michel and Morrissey. Coke was produced at the mine sites in beehive coke ovens. Small-scale coal mining also took place in the northeast, and in the Merritt, Tulameen, and Princeton areas in south-central British Columbia. Production nearly stopped in the 1950's in British Columbia but since the middle 60's exploration and production have blossomed, mainly because of sales of metallurgical (coking) coal to Japan. In the 1970's, use of coal for power generation has reawakened interest in thermal coals. As a result, much exploration has been done in the southeast, in the northeast, and in the Hat Creek Coalfield. At this time, the main reserves in the province are in the Southeast and Northeast Coalfields.

COAL FORMATION

Coal forms when accumulations of plant remains are converted to carbon. Most coals started as thick peat accumulations, generally in coastal areas, in forested swamps, in reed moors, or in open water. Coals are made up mostly of tree and plant debris but some form from deposits of algae. The coal itself looks, feels, and acts differently depending on the completeness of the conversion of this plant debris to carbon. The amount of carbon in the coal is called its 'rank.' From low to high rank, coals change from brown coal to lignite to sub-bituminous to bituminous and finally to anthracite. Deeper burial and higher temperatures cause rank to go up.

The composition of the coal controls the ways it can be used. For example, some coal can only be used to generate steam for making electrical power but others are good for making coke which is used as smelter feed in making steel. The quality of the coal, that is, whether it ends up as thermal or coking coal, depends on its rank and on the amount of inert and volatile matter in it. When the coal is heated, volatile matter changes into gas whereas inert matter does not react chemically and does not burn. Dust, rock fragments, and the like are inerts.



DISTRIBUTION OF OIL, GAS AND MAJOR COAL–BEARING FORMATIONS IN BRITISH COLUMBIA
FIGURE 2

SYNTHETIC FUELS, THE FUTURE

In the petrochemical industry it's been said that 'you can make anything from coal except money.' In the present world energy supply situation, the statement is close to true. However, a breakdown in the supply of petrochemical raw materials or a research breakthrough could make synthesis of petrochemicals, like oil from coal, economically attractive.

Political uncertainties in the oil supplying nations gave the incentive to re-examine old methods, such as coal gasification, and spurred research on large scale coal conversion technology. Research is directed toward improvements in old methods and discovery of new ones. Methods involving biomass conversion for example are so new they've never been tried at production levels.

Coal consists largely of carbon and carbon is the basic building block that is combined with hydrogen in various ways to make hydrocarbons. Coal is plentiful. As world oil supplies diminish and the price rises, making oil from coal will become cost competitive. Some British Columbia coals have the right composition to make a coal gasification industry in the province feasible in the future.

One of the problems with coal conversion is that the 'money products' must be separated from the unwanted products. Much research is being done to try to discover catalysts that will selectively produce the desired products. Another problem is cost – building a conversion plant costs billions of dollars.

NATURAL GAS IN THE FUTURE OF BRITISH COLUMBIA

While the province produces little oil, it has very extensive reserves of natural gas. Presently the gas is used mainly for heating and industrial purposes. These uses will continue but new initiatives will encourage industries that utilize natural gas as feedstock. Recently, steps have been taken toward building a plant in Prince Rupert that will produce liquefied natural gas for export. Proposals have also been made to use natural gas in the manufacture of ammonia-urea fertilizer and to create a petrochemical industry in British Columbia.

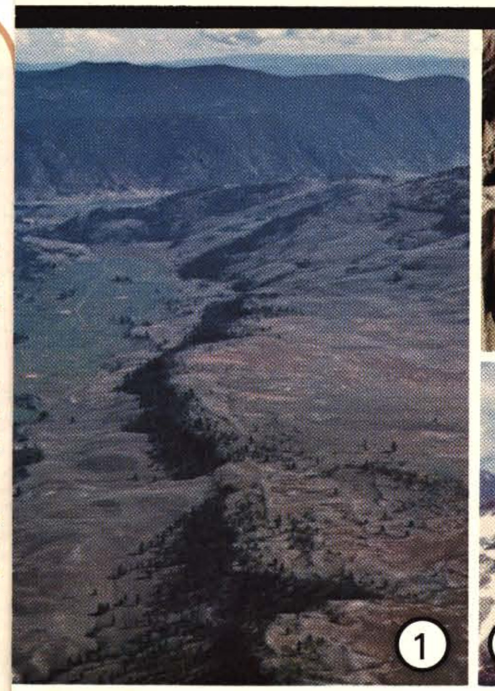
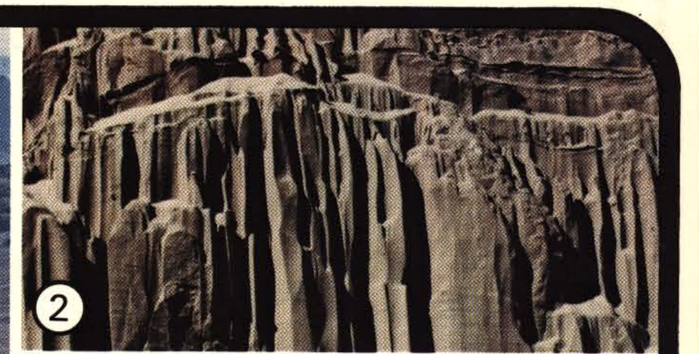
OIL AND GAS IN BRITISH COLUMBIA

Some wild theories have been put forth to explain the origin of oil and gas. It has been suggested that they are of animal or vegetable origin, that they are strange minerals, and even that they are brought to earth by meteorites. Now that a great deal of information has been gathered, geological and chemical data convince us that oil and gas are fatty matter from the decomposition of microscopic marine plants and animals in organic-rich sedimentary rocks. These tiny creatures lived in surface waters; when they died, their remains sank and were mixed in with bottom muds. In ordinary bottom muds, bottom dwellers and burrowing animals would have eaten their carcasses. It was only in muds that were stagnant, with no free oxygen and no bottom dwellers, that the oil-formers were preserved. This environment occurs most commonly in bays, gulfs, coastal lagoons, and enclosed seas where water circulation is restricted.

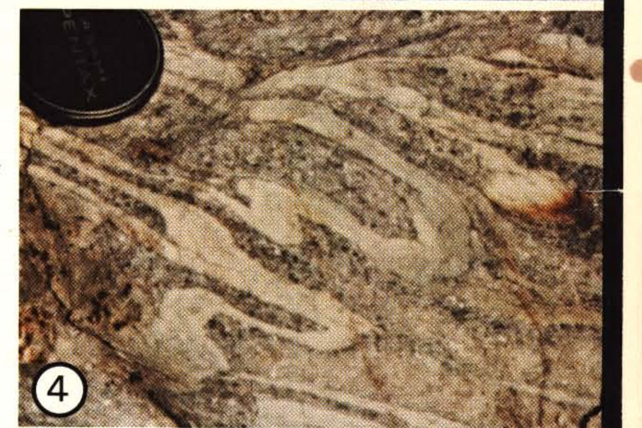
About 500 million years ago, a vast sea covered what are now the Canadian prairies and extended westward. For many millions of years sediments accumulated in the sea, adding layer upon layer on top of older organic-rich sediments. Gradually, the deeply buried sediments turned to rock or 'lithified.' Heat and pressures caused both by burial and by mountain building forces activated bacteria and as the bacteria fed on the microscopic carcasses, they produced oil and gas. The bacteria involved do not need oxygen; in fact, they would find it poisonous.

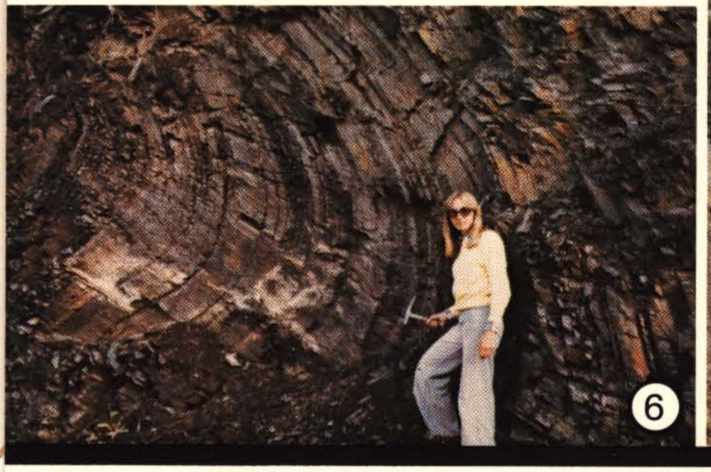
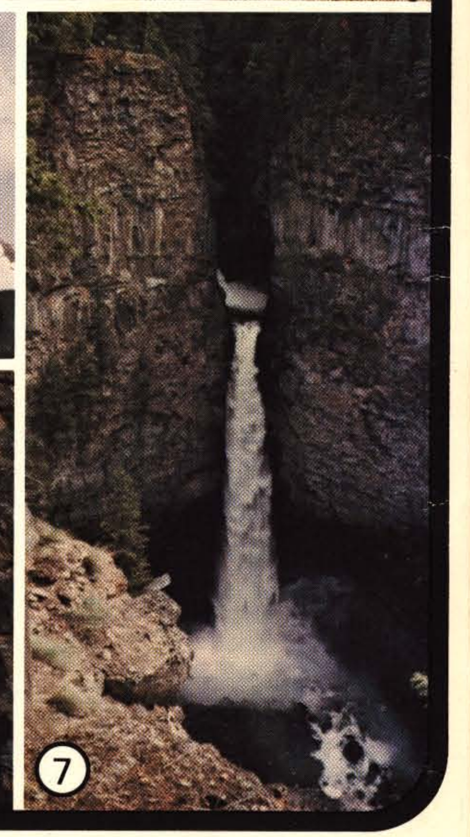
Bacterial activity of this type produces microscopic droplets of oil and gas that are dispersed in the source rock. However, these droplets are very light so they gradually squeeze out and move upward toward the surface. If they reach the surface, they are lost as oil seeps or gas leaks. If they get trapped underground, they can gradually form the large accumulations that we call oil and gas fields. In most oil and gas fields, the 'pay zones' are porous rocks, like sandstones or limestones. Often these are 'capped' by muddy (impermeable) rocks, like shale, which stop the oil and gas from moving upward. It should be stressed that oil and gas occur as tiny globules, as bubbles between rock grains, and in vugs in the reservoir rock; they do not form huge underground 'lakes' of oil or gas. If the oil that forms gets trapped in the source rock, that is, if the source rock is impermeable, then oil shales, like those mined in northern Alberta, result. Similar shales may occur in the Queen Charlotte Islands.

So far in British Columbia, oil and gas are only produced in the Peace River area (Fig. 2). This area is also more or less the same area as the Northeast Coalfield and is part of the Great Plains, from which Alberta's production comes. In British Columbia, gas is much more abundant than oil. In the future, other areas, such as the Flathead in southeast British Columbia; the Rocky Mountains; or offshore, perhaps Hecate Strait, may become producers.

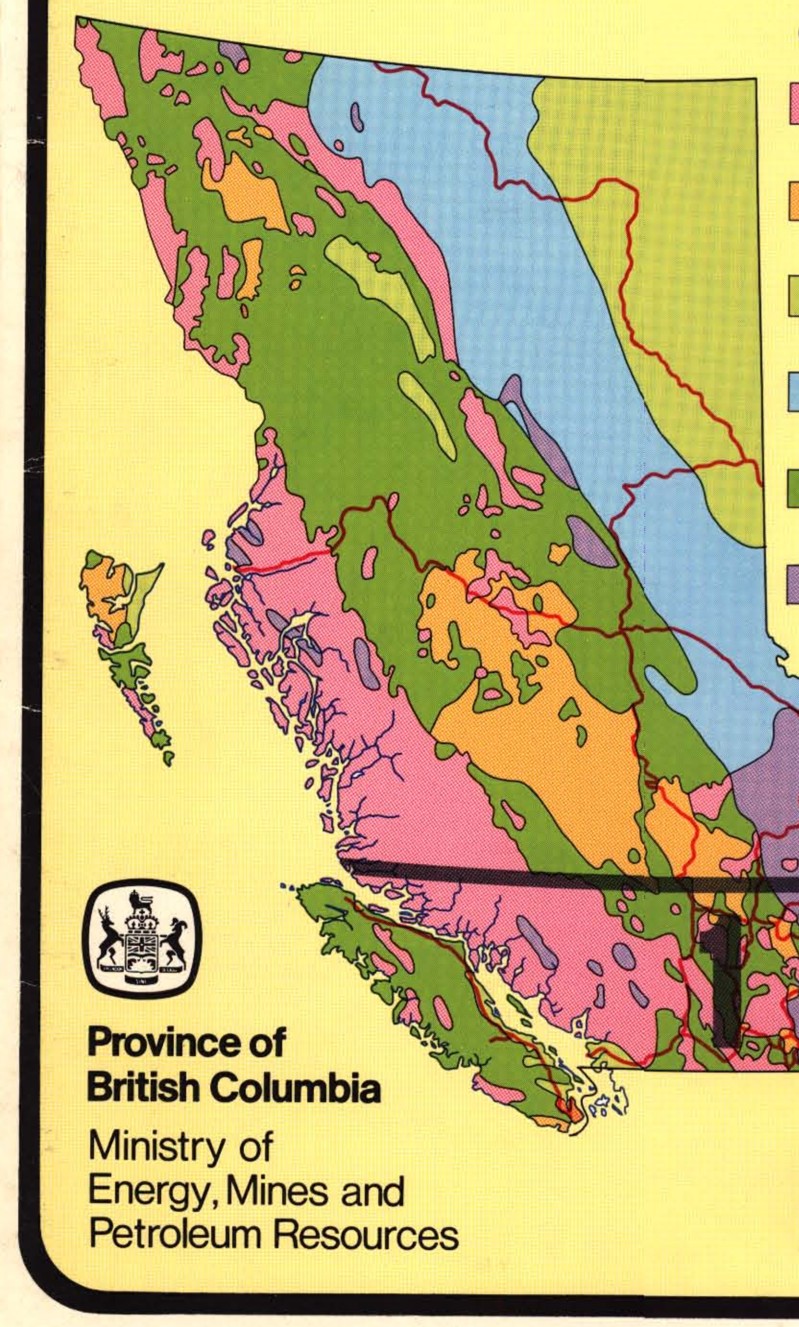




1. Ridge of one–half million year old valley basalt near Nicola Lake.
2. Fluted differentially weathered gravelly glacial outwash sands, Fraser canyon.
3. Knee-shaped folds in Bush River area, Rocky mountains.
4. Flow folded metasedimentary rocks in Monashee Mountains.
5. Mt. Fitzwilliam from near Fraser River bridge, on highway 16. Dark colored sandstone over lighter dolomite.
6. Cleavage folds in slates, Hughes Range, southeastern British Columbia.
7. Waterfall in massive to columnar jointed basalts in Wells Gray Park.



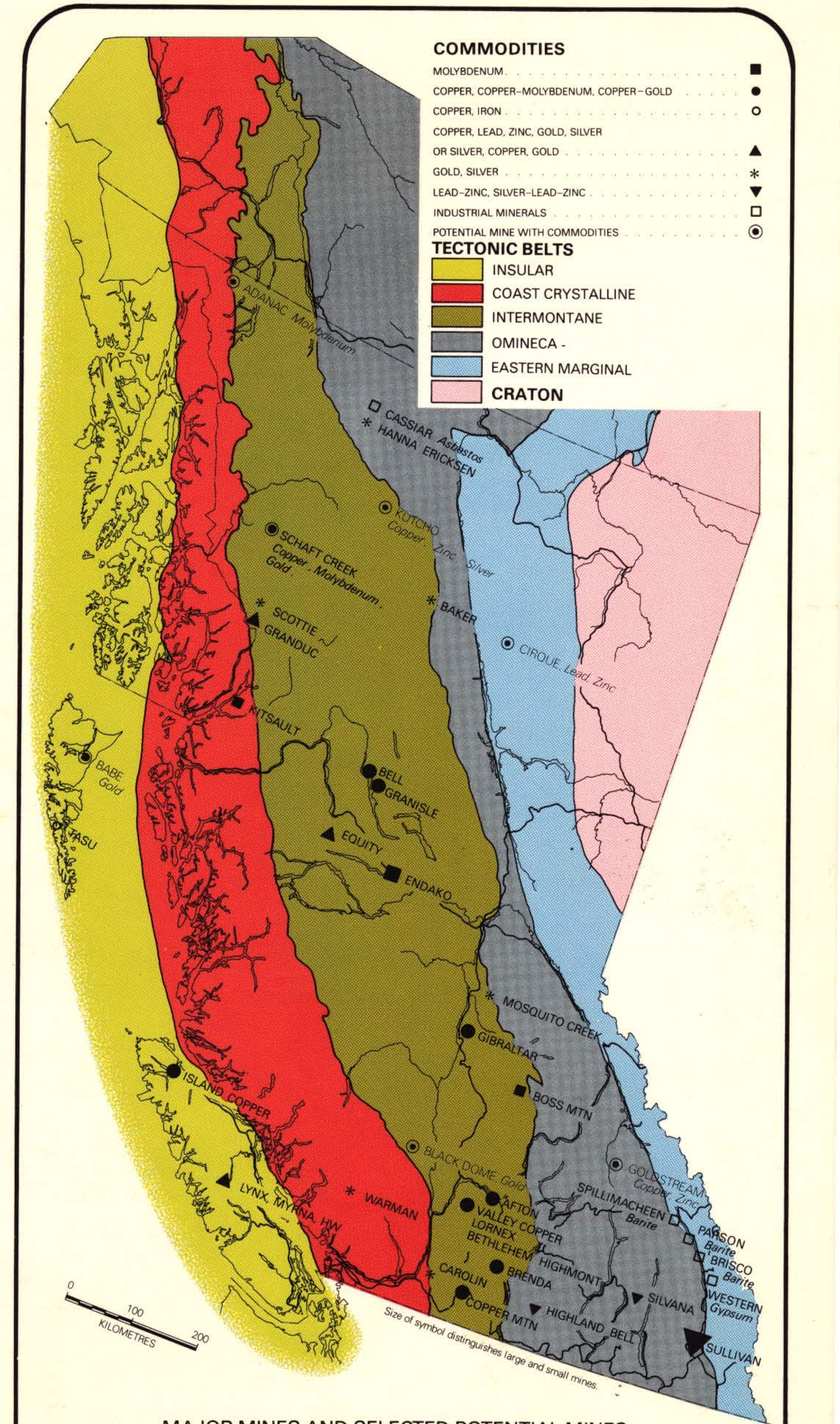



BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAP



Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

MAP 1



MAJOR MINES AND SELECTED POTENTIAL MINES
IN BRITISH COLUMBIA
FIGURE 1

LEGEND

TIME (MILLION YEARS)		SEDIMENTARY ROCKS: MAINLY SHALE, SANDSTONE, SILTSTONE, CONGLOMERATE	SEDIMENTARY ROCKS: MAINLY LIMESTONE, DOLOMITE	VOLCANIC ROCKS: MAINLY ANDESITE, BASALT, RHYOLITE
	CENOZOIC			
	QUATERNARY			
– 1.0 –	PLEISTOCENE AND RECENT (GLACIAL DEPOSITS, DRIFT)	Q		
	UPPER TERTIARY AND QUATERNARY			
	MIOCENE AND LATER (PLATEAU BASALTS, UNDEFORMED VOLCANIC PILES)			uTQ
– 22.5 –	**TERTIARY**	T		
	LOWER TERTIARY			
– 65 –	**PALEOCENE TO OLIGOCENE** (OMT – INCLUDES SOME MIOCENE)			lT
	MESOZOIC			
– 143 –	**CRETACEOUS** (KT – INCLUDES SOME TERTIARY)	K KT		K KT
– 205 –	**JURASSIC** (JK – INCLUDES SOME CRETACEOUS)	J JK		J JK
– 245 –	**TRIASSIC** (TRJ – INCLUDES SOME JURASSIC)	TR TRJ	TR	TR TRJ
	UPPER PALEOZOIC			
– 365 –	**MIDDLE DEVONIAN TO PERMIAN** uP, uPTR, D, DP, DTR, DJ, C, CP, M, MP, MTR, PP, P, PTR			
	LOWER PALEOZOIC			
– 575 –	**CAMBRIAN TO LOWER DEVONIAN** lP, l€, €, €D, €O, O, S, SD, D			
	PROTEROZOIC			
– 1000 –	**HADRYNIAN (WINDERMERE)** (HC – INCLUDES SOME CAMBRIAN) (HD – INCLUDES SOME DEVONIAN)	H	H	
– 1700 –	**HELIKIAN (BELT – PURCELL)**	H	H	

UNDIFFERENTIATED METAMORPHIC ROCKS

INTRUSIVE ROCKS

MAINLY GRANITE, GRANODIORITE, DIORITE

TIME (MILLION YEARS)	
– 30 –	**CENOZOIC**
	MlT — MIDDLE TO LATE TERTIARY
– 80 –	**LATE MESOZOIC – CENOZOIC**
	KT — LATE CRETACEOUS TO EARLY TERTIARY
– 143 –	**MESOZOIC**
	K — EARLY TO LATE CRETACEOUS
– 195 –	J — MIDDLE TO LATE JURASSIC
– 245 –	TRJ — LATE TRIASSIC TO EARLY JURASSIC
– 575 –	**PALEOZOIC**
	P
– 1700 –	**PROTEROZOIC**
	P

MESOZOIC AND TERTIARY

MT — COAST RANGE PLUTONIC COMPLEX

LATE PALEOZOIC AND MESOZOIC

ULTRAMAFIC ROCKS

GEOLOGIC AGE SYMBOLS

Q	QUATERNARY	P	PENNSYLVANIAN	P	PALEOZOIC
m	MIOCENE	M	MISSISSIPPIAN	P	PROTEROZOIC
o	OLIGOCENE	D	DEVONIAN		
T	TERTIARY	S	SILURIAN		
K	CRETACEOUS	O	ORDOVICIAN		
J	JURASSIC	€	CAMBRIAN	u	upper
TR	TRIASSIC	H	HADRYNIAN	l	lower
P	PERMIAN	H	HELIKIAN	l	LATE
C	CARBONIFEROUS	M	MESOZOIC	M	MIDDLE

NOTE: uPTR means upper PALEOZOIC to TRIASSIC inclusive.

SYMBOLS

HIGHWAYS:
- ARTERIAL AND SECONDARY
- LOCAL

FERRY (ROUTE AND DISTANCE)

HOSPITAL

FAULTS: NORMAL

THRUST

GEOLOGICAL CONTACT

DISTANCE IN KILOMETRES ● 29 ●

BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAPS

Production Staff: Legend and Geological Compilation, E. V. Jackson.
Coordination and text, W. J. McMillan
Cartography, J. Armitage
Text production, R. Moir

Acknowledgment and financial support of the following two organizations is gratefully acknowledged:

Cordilleran Section,
Geological Association of Canada,
Vancouver, B.C.

Canadian Society of Petroleum Geologists,
Calgary, Alberta

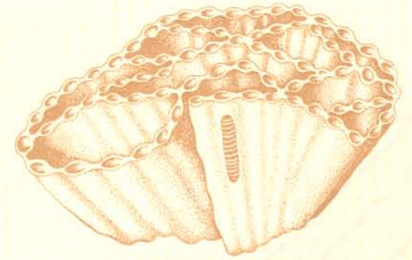
Geology derived mainly from the following geological maps compiled by officers of the Geological Survey of Canada, 100 West Pender Street, Vancouver:

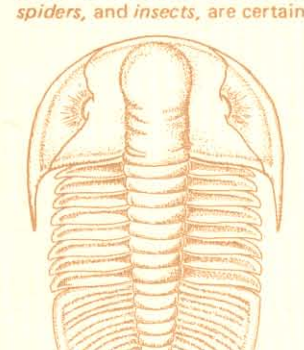
MAP NAME	COMPILED BY	OPEN FILE NO.	SCALE
Fraser River	A. V. Okulitch	165	1:1 million
Skeena River	A. V. Okulitch	166	1:1 million
Parsnip River	R. B. Campbell, *et al.*	261	1:1 million
Kootenay River	A. V. Okulitch and G. J. Woodsworth	481	1:1 million
Vancouver Island	J. E. Muller	463	1:250 000
Tectonic Assemblage Map of the Canadian Cordillera	H. W. Tipper, *et al.*	572	1:2 million
Geological Map of Part of the Southeastern Canadian Cordillera	R. B. Campbell	----	1:1 million

ORIGIN AND EVOLUTION OF LIFE

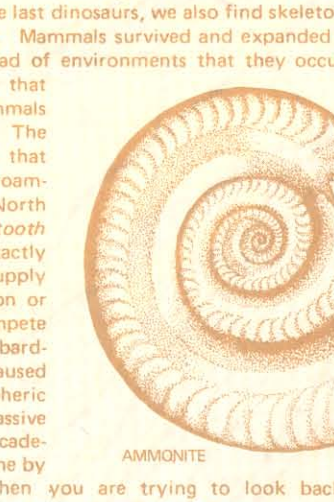
No agreement exists on how either life originated or how it evolved. We estimate that the solar system formed 12 billion years ago; that the earth originated about 4.6 billion years ago; and that the first bits of the earth's granitic crust solidified about 3.5 billion years ago. We cannot see or estimate exactly when or how life began but rocks that are 2 billion years old carry remains of relatively simple plant life (*algae*).

The timing of the appearance of animal life is equally uncertain. Remains (fossils) of the earliest known animals have no hard parts. As a result, they rarely are preserved as fossils. Fossil entries in the rock record suddenly became abundant about 600 million years ago. They show that a wide variety of complex marine plants and animals lived in the ancient, Cambrian seas. Many new kinds of plants and animals appear as one scans along the time line of the rock record. Veritable explosions in abundance of given genera occur, commonly followed by rapid decline. For example, *trilobites,* a kind of arthropod, dominated the Cambrian seas but had disappeared by the Paleozoic time. However, their descendants, *crabs, spiders,* and *insects,* are certainly abundant and diversified today. Other examples of life forms that were abundant but are now extinct include *graptolites, conodonts, ammonites,* and of course *dinosaurs.* Dinosaurs ruled the earth for nearly 150 million years; now only fossils tell us that they ever existed.


HALYSITES (CORAL)

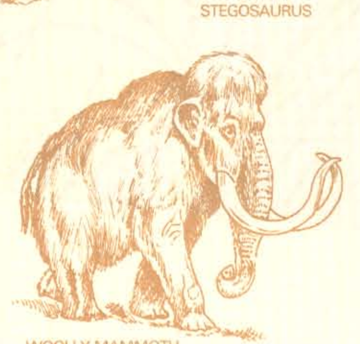

TRILOBITE

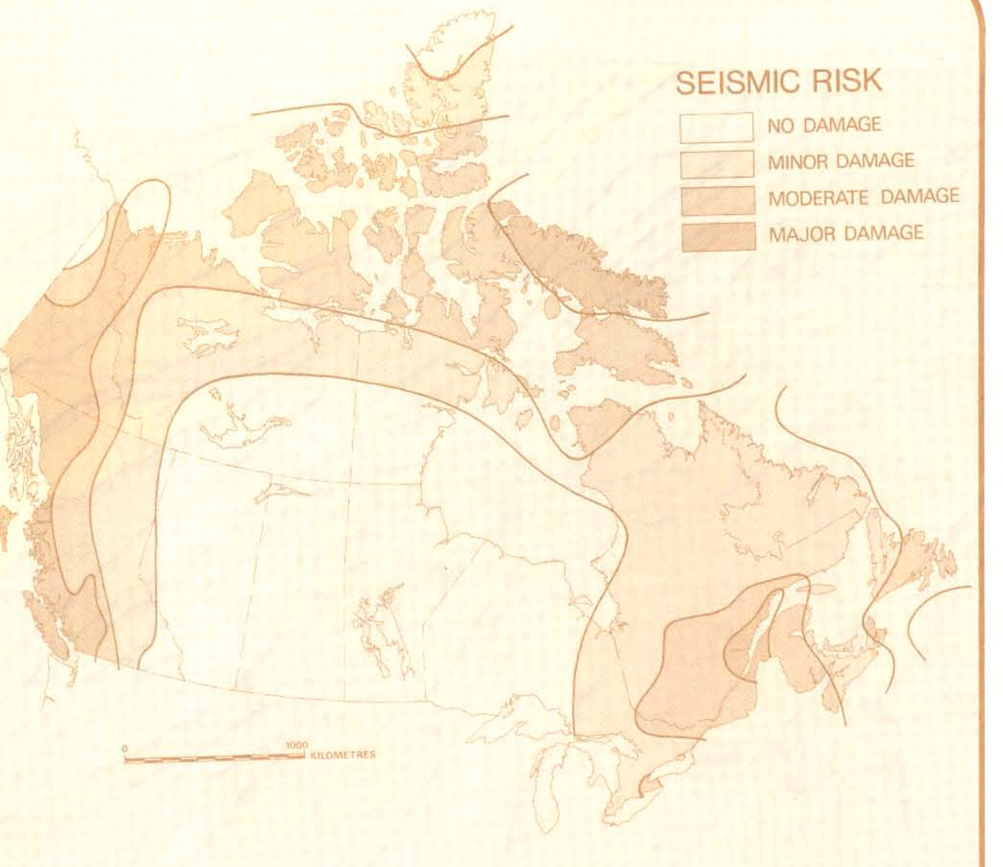
In a geological sense, mammals appeared on the scene relatively recently, only 65 million years ago. In the same rock layers that we find fossils of the last dinosaurs, we also find skeletons of tiny, *shrew-like mammals.* Mammals survived and expanded and diversified into the myriad of environments that they occupy today. That is not to say that all species of mammals were successful. The fossil record shows that giant sloths once roamed the plains of North America. *Sabre tooth tigers* and *mammoths* are extinct; we do not know exactly why they disappeared. Perhaps it was loss of food supply due to changes in climate; perhaps it was predation or mutation or disease; perhaps it was inability to compete with other life forms. It has been argued that bombardment by cosmic rays during magnetic reversals caused widespread extinctions. Perhaps it was atmospheric dust from impacts of huge meteorites or from massive volcanic eruptions that caused drastic and sudden decade-long changes in world climate. Facts are hard to come by when you are trying to look back tens or hundreds of millions of years. We must rely on the fossil record, comparisons with modern examples, and inspired guesses; but it's really like trying to assemble a jigsaw puzzle when most of the pieces are missing!


AMMONITE


STEGOSAURUS

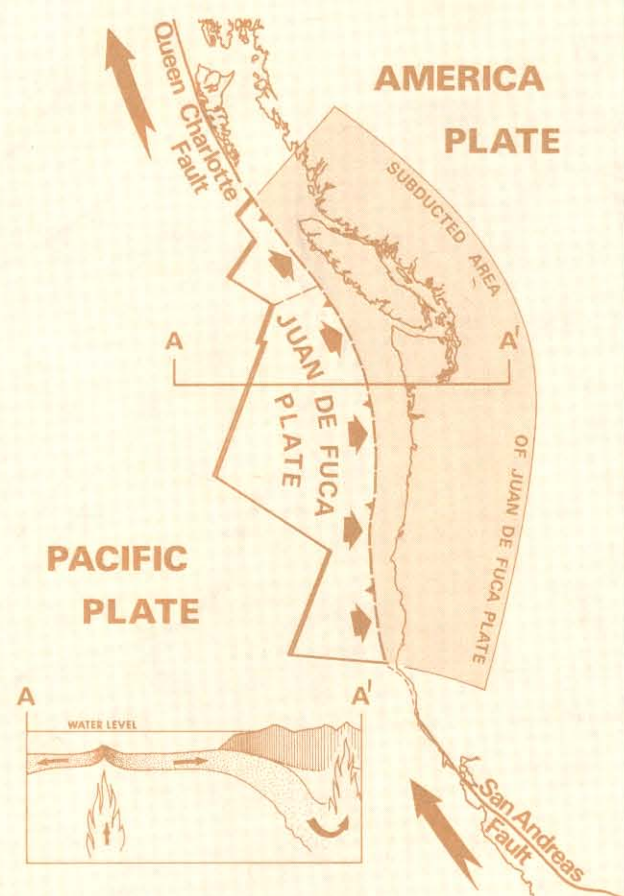

TITANOTHERES


WOOLLY MAMMOTH



SEISMIC RISK

Earthquakes are everyday occurrences along the west coast of North America, but, fortunately, most are offshore. Gary Rogers' in an article in the January 1981 issue of *The B.C. Professional Engineer,* described seismic or earthquake risk in the light of plate tectonic theory. Along the west coast of British Columbia, earthquakes are caused by slip movements along the Queen Charlotte and similar faults and by underthrusting or subduction of the Juan de Fuca plate under the America plate. In the Puget Sound area, many earthquakes occur opposite the bend in the coastline where it swings from north-south in Washington/ Oregon to northwest-southeast in British Columbia. For example, large earthquakes of magnitude 6 to 7 caused damage in the San Juan Islands in 1909 and in Seattle, Tacoma, and Olympia in 1947, 1949, and 1965. Victoria and area have also been shaken periodically but the magnitude was lower and damage has been minimal.

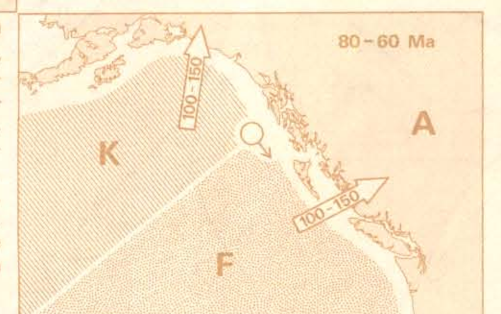


THE LAST 100 MILLION YEARS

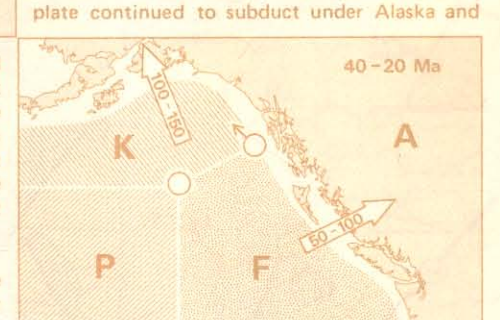
The following description of plate tectonic reconstructions that depict the last 100 million years in the Cordillera is condensed from an article by R. Riddihough in *Geoscience Canada* (Number 9, Volume 1), March 1982.

Middle to Late Cretaceous (100 – 80 Ma) evidence is weak but evidently there was a single subduction plate (Farallon) moving north-northeast under the coast (America plate).

Late Cretaceous to Middle Paleocene (80 – 60 Ma) evidence is slightly better. In this period, the Kula plate came into being and was interacting with the America plate. The Farallon-Kula boundary was a spreading ridge system. Farallon motion remained north-northeast relative to the America plate. Rates of movement, at 100 to 150 kilometres each million years, were apparently higher than previous rates. The point where all three plates meet (triple junction) was north of the present Queen Charlotte Islands and migrated southward.



Oligocene to Early Miocene (40 – 20 Ma) saw drastic changes occur. About 40 million years ago (Late Eocene) out in the Pacific, a 50-degree change in movement direction of the Pacific plate took place. One effect of this change is seen as the bend in the Hawaiian Island Emperor Seamount chain. Off our west coast, the changes were dramatic. Movement directions only shifted slightly but rates were cut in half on Farallon plate and the triple junction moved rapidly northward. The Kula plate continued to subduct under Alaska and by the end of this period the Kula plate had been totally consumed. The rate of movement of Farallon plate continued to decrease and the Farallon-Pacific-America plate triple junction migrated southward. Farallon movement direction was unchanged but Pacific plate motion shifted to the north-northwest as it subducted under the Aleutian Islands.



Late Miocene through Pliocene and Pleistocene (10 – 0 Ma) saw spreading rates continue their slowing trend. The Juan de Fuca ridge began to rotate clockwise about 5million years ago, which caused the rate of subduction under America plate to slow even more. Only fragments of the Farallon plate now remain. The one off Vancouver Island is called the Juan de Fuca plate. The Queen Charlotte fault was initiated and grew as subduction under the mainland stopped and the triple point migrated southward as far as the north end of Vancouver Island where it is today.

ABBREVIATIONS AND SYMBOLS

Plate movement in kilometres each million years relative to America plate

Triple junction location and movement direction

F = Farallon plate
K = Kula plate
A = America plate
P = Pacific plate
Ma = million years

YOUNG VOLCANOES AND HOT SPRINGS

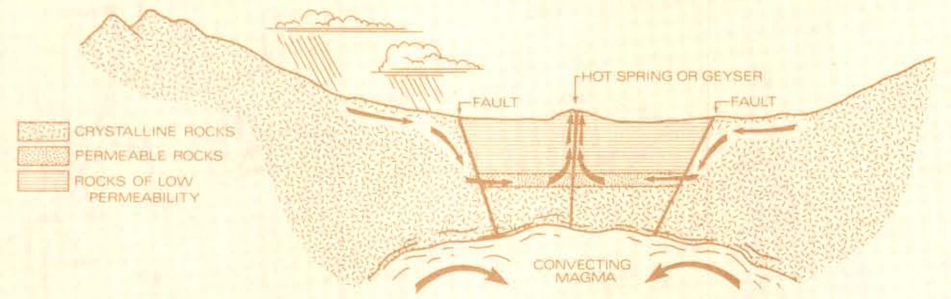
Young volcanoes and hot springs along the cordillera can be related to plate tectonic movements. Changes in the movement directions explain volcanism and shifts in centres of volcanic activity.

Eastward movement of the Farallon plate under Vancouver Island and the mainland resulted in subduction of oceanic crust under the continent. As the toe of the subducted oceanic crust moved deeper it began to melt. For example, subduction caused a chain of volcanoes (Cascades) to form inland from the subduction trench caused by Juan de Fuca plate movement. The Mount St. Helens volcano shows that this system is still active!

In British Columbia, large areas of subaerial Miocene volcanic rocks are related to this subduction. Smaller areas in the north relate to subduction of the Pacific plate under the America plate.

Volcanism in British Columbia that is related to destruction of the north part of the Farallon plate (Explorer plate) ended after the movement direction of the plate shifted so that subduction stopped. The shift took place about half a million years ago. Melting continued in the toe of the subducted slab for some time after the shift but volcanism gradually died out.

The youngest recorded volcanic activity in the Garibaldi belt near Vancouver was 2 500 years ago. It was probably triggered by ice loading and unloading, not plate tectonics. The youngest volcanic activity in the province was near Stewart, where the last eruption was only about 200 years ago.



HOT SPRINGS

In a general way, hot springs in British Columbia occur in two northwest-trending zones. The east zone is related to the Rocky Mountain Trench, the west zone to the coast. Hot springs in the east zone are in sedimentary rocks, but most of those in the west are allied with areas of recent volcanic activity.

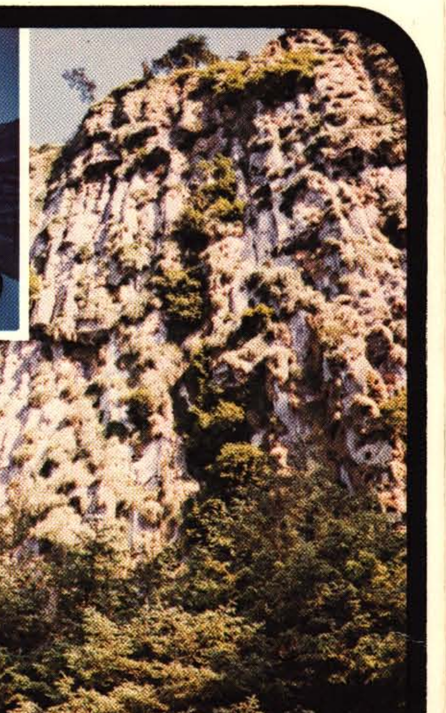
Water in the eastern, sedimentary rock hot springs is hot because it comes from deep in the earth. Groundwater dribbles downward along faults to great depths then follows other faults back up to the surface. The temperature of the earth increases downward and, if it goes deep enough, water can be heated above boiling temperature. Waters in Banff hot springs, for example, apparently originate in Sundance Creek and trickle down along fractures to depths of more than 6 kilometres (20,000 feet) before coming back up along a fault.

In areas of recent lava flows, even groundwater close to surface can become heated. The surfaces of lava flows cool very quickly but inside, especially if several flows lie above one another, cooling is slow. Groundwater coming near the hot lava is superheated and either comes back to the surface as steam or mixes with cold water on the way and forms hot springs. Many of the coastal hot springs form this way.

Also in such areas, some magmas get trapped at depth and never reach the surface to erupt as lava. Because they are in a thick blanket of warm cover rocks, these intrusive magmas take a very long time (millions of years) to cool. Groundwaters that come close to them become heated and can re-emerge as hot springs. Springs in the Ainsworth area may originate in this fashion and those near Meager Mountain north of Vancouver most certainly do.

The hot waters are rich in dissolved minerals which redeposit as the water cools. Thus many springs have interesting tufa [calcite $CaCO_3$ or dolomite $CaMg(CO_3)_2$] or sinter (silica) deposits. Heat and chemical variations cause each spring to have its own unique and fascinating eco-system.

YOUNG VOLCANOES AND HOT SPRINGS IN BRITISH COLUMBIA
FIGURE 4

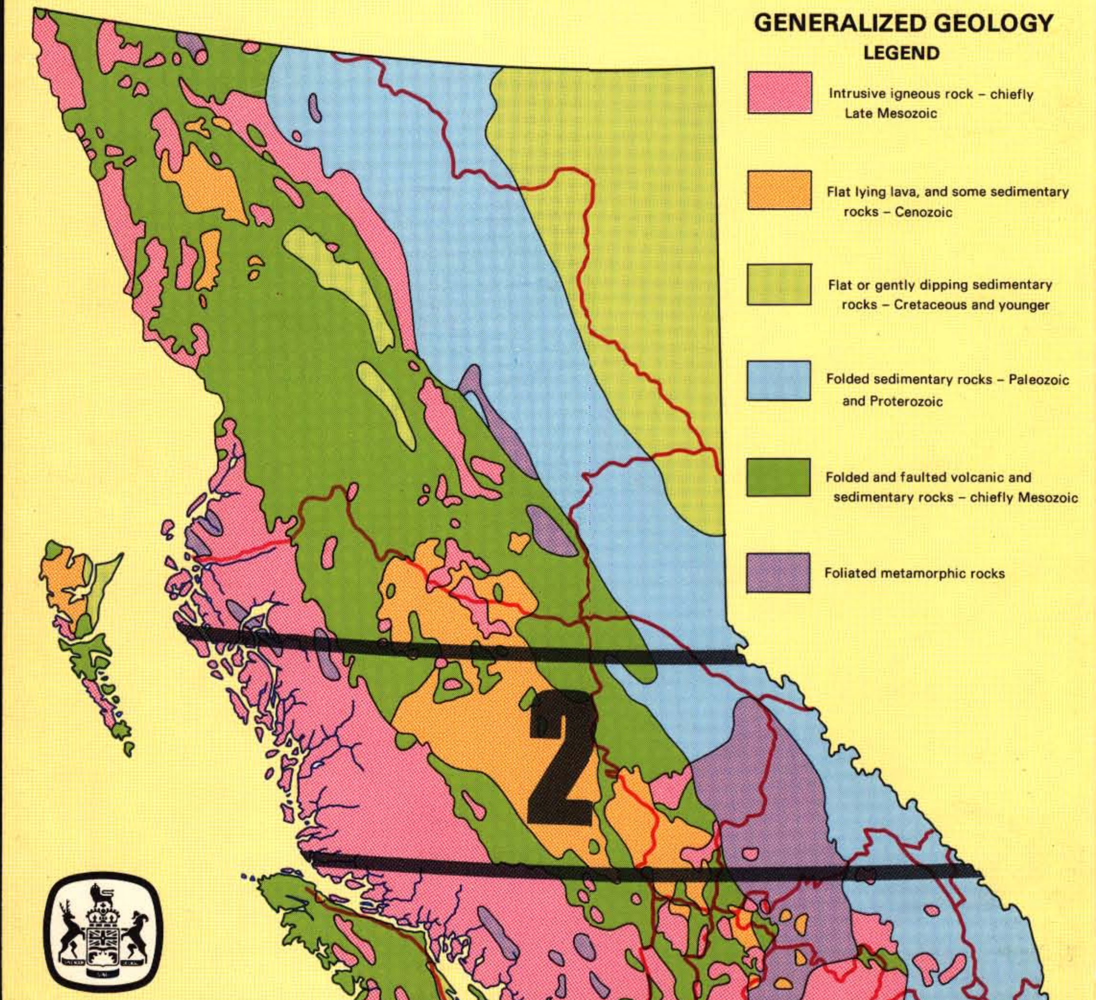




1. View north up Atlin Lake from Williston Bay.
2. Beach, Graham Island, Queen Charlotte Islands.
3. Jagged glacial ice, Stikine area.
4. Pillowed basaltic lavas from near Sooke, southern Vancouver Island.
5. Columns in basalt. Tow Hill, Graham Island.
6. Hanging glacier ; denuded area below shows recent melt - back of ice, Sphaler Ck.
7. Tight folds in sedimentary rocks in a tributary of Sullivan River, Rocky Mountains.
8. Glacier in tributary of Stikine River.





BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAP



Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

MAP 2

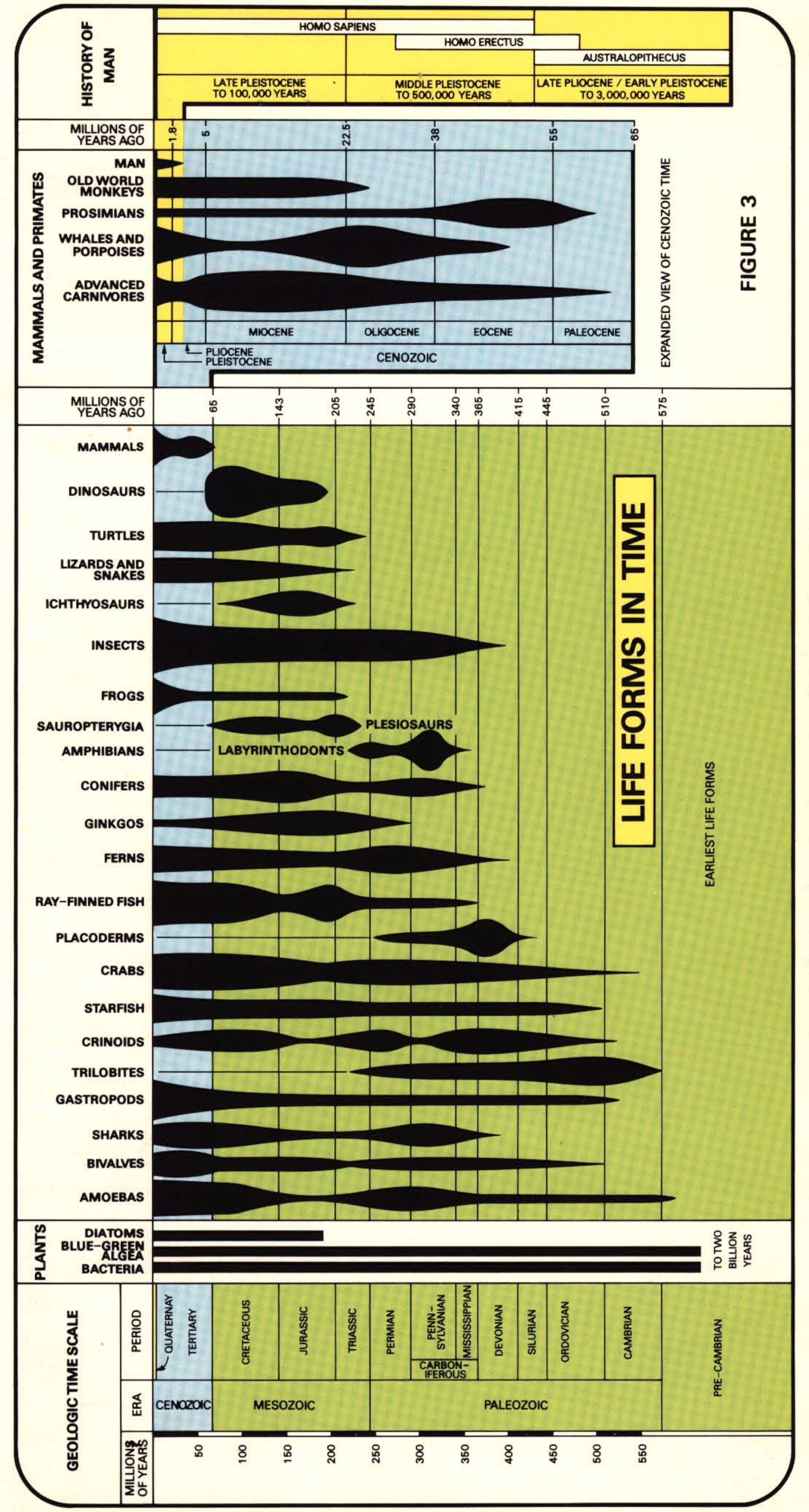


FIGURE 3

LEGEND

SEDIMENTARY ROCKS / VOLCANIC ROCKS

MAINLY SHALE, SANDSTONE, SILTSTONE, CONGLOMERATE — MAINLY LIMESTONE, DOLOMITE — MAINLY ANDESITE, BASALT, RHYOLITE

TIME (MILLION YEARS)

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT (GLACIAL DEPOSITS, DRIFT) — Q

– 1.0 –

UPPER TERTIARY AND QUATERNARY

MIOCENE AND LATER (PLATEAU BASALTS, UNDEFORMED VOLCANIC PILES) — uTQ

– 22.5 –

TERTIARY — T

LOWER TERTIARY

PALEOCENE TO OLIGOCENE (OMT – INCLUDES SOME MIOCENE) — lT

– 65 –

MESOZOIC

CRETACEOUS (KT – INCLUDES SOME TERTIARY) — K KT; K KT

– 143 –

JURASSIC (JK – INCLUDES SOME CRETACEOUS) — J JK; J JK

– 205 –

TRIASSIC (TRJ – INCLUDES SOME JURASSIC) — TR TRJ; TR; TR TRJ

– 245 –

UPPER PALEOZOIC

MIDDLE DEVONIAN TO PERMIAN
uP, uPTR, D, DP, DTR, DJ, C, CP, M, MP, MTR, PP, P, PTR

– 365 –

LOWER PALEOZOIC

CAMBRIAN TO LOWER DEVONIAN
lP, l€, €, €D, €O, O, S, SD, D

– 575 –

PROTEROZOIC

HADRYNIAN (WINDERMERE) (HC – INCLUDES SOME CAMBRIAN) (HD – INCLUDES SOME DEVONIAN) — H; H

– 1000 –

HELIKIAN (BELT – PURCELL) — H; H

– 1700 –

UNDIFFERENTIATED METAMORPHIC ROCKS

INTRUSIVE ROCKS

MAINLY GRANITE, GRANODIORITE, DIORITE

TIME (MILLION YEARS): – 30 –, – 80 –, – 143 –, – 195 –, – 245 –, – 575 –, – 1700 –

CENOZOIC

MLT — MIDDLE TO LATE TERTIARY

LATE MESOZOIC – CENOZOIC

KT — LATE CRETACEOUS TO EARLY TERTIARY

MESOZOIC

K — EARLY TO LATE CRETACEOUS

J — MIDDLE TO LATE JURASSIC

TRJ — LATE TRIASSIC TO EARLY JURASSIC

PALEOZOIC

P

PROTEROZOIC

P

MESOZOIC AND TERTIARY

MT — COAST RANGE PLUTONIC COMPLEX

LATE PALEOZOIC AND MESOZOIC

ULTRAMAFIC ROCKS

GEOLOGIC AGE SYMBOLS

Q	QUATERNARY	P	PENNSYLVANIAN	P	PALEOZOIC
m	MIOCENE	M	MISSISSIPPIAN	P	PROTEROZOIC
O	OLIGOCENE	D	DEVONIAN		
T	TERTIARY	S	SILURIAN		
K	CRETACEOUS	O	ORDOVICIAN		
J	JURASSIC	€	CAMBRIAN	u	upper
TR	TRIASSIC	H	HADRYNIAN	l	lower
P	PERMIAN	H	HELIKIAN	l	LATE
C	CARBONIFEROUS	M	MESOZOIC	M	MIDDLE

NOTE: uPTR means upper PALEOZOIC to TRIASSIC inclusive.

SYMBOLS

HIGHWAYS:
ARTERIAL AND SECONDARY . . . .
LOCAL . . . .
FERRY (ROUTE AND DISTANCE) . . . .
HOSPITAL . . . . +
FAULTS: NORMAL . . . .
THRUST . . . .
GEOLOGICAL CONTACT . . . .
DISTANCE IN KILOMETRES . . . . • 29 •

BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAPS

Production Staff: Legend and Geological Compilation, E. V. Jackson.
Coordination and text, W. J. McMillan
Cartography, J. Armitage
Text production, R. Moir

Acknowledgment and financial support of the following two organizations is gratefully acknowledged:

Cordilleran Section,
Geological Association of Canada,
Vancouver, B.C.

Canadian Society of Petroleum Geologists,
Calgary, Alberta

Geology derived mainly from the following geological maps compiled by officers of the Geological Survey of Canada, 100 West Pender Street, Vancouver:

MAP NAME	COMPILED BY	OPEN FILE NO.	SCALE
Fraser River	A. V. Okulitch	165	1:1 million
Skeena River	A. V. Okulitch	166	1:1 million
Parsnip River	R. B. Campbell, *et al.*	261	1:1 million
Kootenay River	A. V. Okulitch and G. J. Woodsworth	481	1:1 million
Vancouver Island	J. E. Muller	463	1:250 000
Tectonic Assemblage Map of the Canadian Cordillera	H. W. Tipper, *et al.*	572	1:2 million
Geological Map of Part of the Southeastern Canadian Cordillera	R. B. Campbell	----	1:1 million

GEOLOGICAL CYCLE

Early in its history, the earth was a ball of molten rock. Gradually, the surface cooled and congealed to form a gradually thickening outer layer of solid rock. But volcanos were everywhere, pouring out lava and blasting out huge amounts of dust and water vapour and other gases. When rains and winds and waves began to erode the first volcanic island formed in the primordial sea, then the geologic cycle had begun.

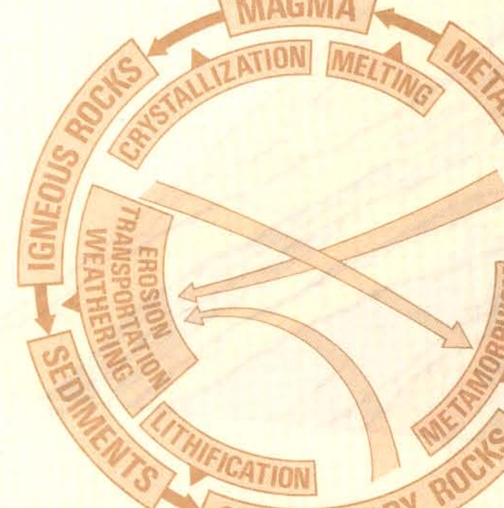
Landforms are the battlescars of the war between the forces of erosion and the combined forces of igneous activity and mountain building. Left to its own devices, erosion would soon reduce the land areas of the earth to a uniform bevelled-off surface. High areas would be worn down and low areas filled in by thick deposits of sediment.

Rock exposed to weather is gradually broken apart by the action of wind and rain, by daily heating and cooling, by freezing, by rivers or streams, or even by cataclysmic events like landslides or volcanic eruptions (remember Mount St. Helens?). The resulting muds, silts, sands, gravels, or boulder debris is then redeposited on slopes, in creek or river valleys, in lakes, or in the ocean. In areas where deep layers of sedimentary material accumulate, the sediments at the bottom, those deposited first, are compressed, water between the grains is forced out, and the grains become cemented together; they become sedimentary rocks. As more and more sediments accumulate, these sedimentary rocks are buried even deeper, are squeezed more, and are heated up. They are heated because temperature rises as you go deeper into the earth. The particles that compose the rock become unstable under these new conditions; they break down and new minerals grow to form 'changed' or 'metamorphic' rocks. If the rocks are buried even deeper, they can partly or completely melt. The melted rock or magma can then move upward along cracks toward the surface. If it gets trapped below surface and cools and solidifies, granitic rocks are formed; if it reaches the surface and erupts as either ash or lava then the cycle begins again.

Granitic, metamorphic, or sedimentary rocks that we see at the surface today formed deep in the earth. We see them only because mountain building forces pushed them up and erosion stripped off all the cover materials.

The cycle outlined above, from igneous activity, to burial, to rock formation, metamorphism, and melting can be interfered with in many ways. Perhaps the two most important are mountain-building forces and igneous intrusions. The former causes anomalous pressure rises; the latter anomalous temperature rises. Both can produce sedimentary rocks or metamorphic rocks or magmas at shallower depth than the simple burial model predicts.

Mountain-building forces originate from interactions of the crust and the underlying mantle (plate tectonics, *see* Fig. 8) and from the effects of loading areas of the crust. The loading could be thick accumulations of sediments or perhaps thick, continent-wide sheets of ice. Whatever it is, the loading causes the bottom of the crust to bow down into the mantle and areas off to the side to get bowed up, that is, they get uplifted. It is like a boat sinking deeper into the water as more people climb into it; however, the boat sinks deeper immediately whereas response time in the mantle is very much slower, hundreds or thousands of years.



GLACIATION: THE ICE AGE IN BRITISH COLUMBIA
FIGURE 6

(MOSTLY AFTER G S C MAP 1253 A)

GLACIATION OF BRITISH COLUMBIA

About 2½ million years ago the climate cooled and moisture-laden Pacific air masses dumped thick layers of snow on mountains in British Columbia. Snow accumulated faster than summer melt-off so glaciers formed and grew and eventually masses of ice covered most of the Province. Naturally the greatest accumulations of snow and ice were along the west sides of the mountains, especially the Coast Mountains, the first barrier faced by the wet air masses. Many ice buildups and meltbacks occurred because the climate varied but the greatest accumulation of ice took place about 15 000 years ago when virtually all the Province was covered. Glaciers are continuing to melt back today, but perhaps this is only another retreat. Perhaps we are still in the Ice Age!

The diagram (Fig. 6) shows where glaciers still exist. At the onset of a glacial epoch, these are the source areas from which new glaciers grow. First they fill the stream valleys, then move away from the mountains down the drainage ways until tongues meet, join together, grow, and finally cover vast areas of the Province and extend down to the ocean. The figure also shows ice movement paths from the last great glacial advance. It began 25 000 years ago, reached Vancouver Island 17 000 years ago, then began to melt back 14 000 years ago. Much of Vancouver Island was ice free by 12 800 years ago but the ice persisted along the Coast Range and clogged the Strait of Georgia until about 10 000 years ago. Ice then gradually receded to roughly its present position. The figure also shows unglaciated areas in the Yukon, the contact to the east with the ice mass that covered the Canadian Shield, and large lakes formed in areas where drainage channels got blocked, usually by ice, as the glaciers melted back.

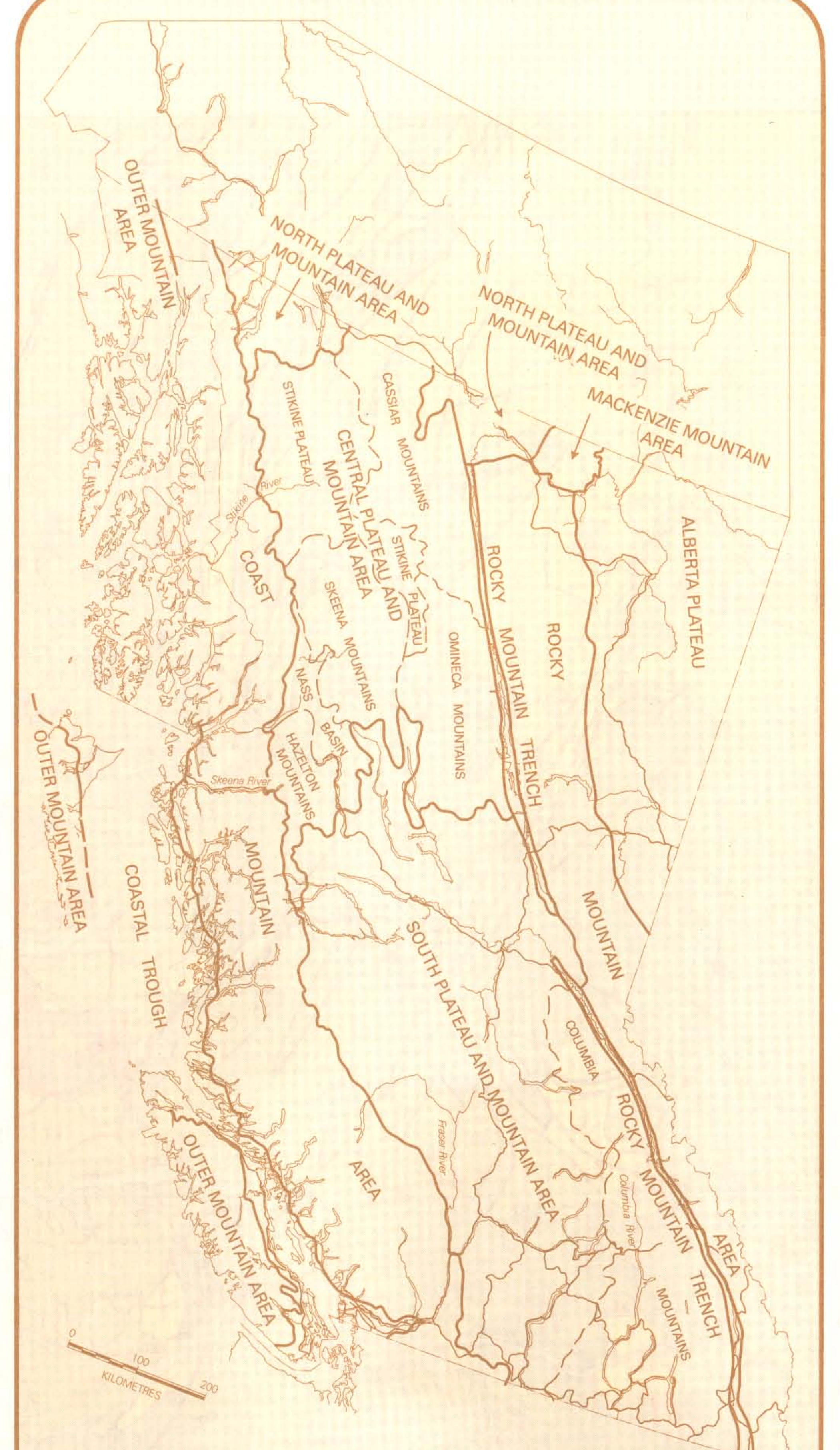
Most of the glacial features that we now see were formed during the last period of glaciation. Hills and mountains that were covered by ice were scraped off and streamlined parallel to ice movement. Rock that the ice rasped across is grooved and polished by scour. The most distinctive glacial deposits, called till, are jumbled mixtures of boulders, sand, and clay. Tills underlie the soil layer in road cuts throughout the Province. Great boulders, called glacial erratics, that are found up to hundreds of kilometres away from their source areas, were carried in or on the ice and dropped at the edge of the ice as it melted. Melting causes debris to pile up at the borders of the ice. These piles of sand, gravel, and boulders are called moraines. Sands and gravels deposited from glacial meltwater rivers are also abundant, for example, in highway roadcuts along the Fraser and Thompson Rivers.

Glaciers flowing westward out of the St. Elias and northern Coast Mountains into the Pacific Ocean formed huge fleets of icebergs. Further south, ice moving west from the Interior and the Coast Mountains collided with that coming off the Queen Charlotte Islands. This collision built up great thicknesses of ice that then oozed northward into Queen Charlotte Sound and southward through the Strait of Juan de Fuca. At the south end of Vancouver Island, the ice was more than 1.5 kilometres thick; it must have looked like Antarctica!

At first, the growing ice masses moved along stream valleys into the interior plateau from all directions. Later, the ice got so thick, more than 1 800 metres, that it flowed eastward over the Rocky Mountains near Prince George and westward over the Coast Mountains and down Portland Canal and into Douglas Channel. In the south, the ice front extended as much as 150 kilometres south of the United States border. In the Okanagan Valley, ice thickness also reached 1 800 metres and at the border it was at least 2 100 metres. Huge volumes of meltwater raged southward down the Columbia River to the Pacific; in one incredible event, the water broke free and flooded the whole of Eastern Washington.

Only local glaciers formed on the Alberta side of the southern Rocky Mountains. North of Athabasca Valley, however, ice crossed the divide and some glaciers from the upper part of the Fraser River system flowed eastward onto the plains where they either melted or merged with the so-called Keewatin ice mass that covered much of the rest of Canada.

In the southern part of the Province, melting of the glaciers (deglaciation) took place when more ice melted each year than came in from the source areas. Gradually, highland areas, then plateaus emerged, and only valleys were ice filled. This valley ice persisted for a long time but gradually thinned and broke up leaving only stagnant lobes in major valleys and lowlands. About 11 000 years ago some of these lobes acted as dams and huge lakes backed up behind them. For example, ice in the Thompson River valley backed up water to form a lake that was nearly 450 metres deeper than the present Nicola Lake. There was also a lake that extended from Cache Creek through Kamloops to include Shuswap Lake and the Arrow Lakes, and similar lakes near Prince George, in the Peace River area, and in the Rocky Mountain Trench. Evidence for these lakes is seen in beach or lake bottom silt deposits that are now high up the valley walls (like the silt cliffs near Kamloops). As deglaciation began, meltwater from the Nicola Valley flowed southward; later it flowed eastward into the Okanagan River system and thence via Columbia River to the Pacific Ocean. As meltback continued, the glacial lakes drained and, when the Fraser River became ice free, water began to follow presentday river systems.



MAJOR PHYSIOGRAPHIC DIVISIONS OF THE CORDILLERA AND INTERIOR PLAINS
FIGURE 7

LANDFORMS OF BRITISH COLUMBIA

The earth's surface is constantly changing. Changes can be catastrophic, like those caused by the Hope landslide, floods, extraordinary storms, or volcanic explosions like Mount St. Helens, but generally are so slow that decades are needed to see them. The main agents that cause erosion and change are water and ice, wind, and chemical breakdown. The rate of erosion is controlled by the height of the hills or mountains, the steepness of the slopes, the amount of rain or snow, temperature ranges, and the nature of the underlying bedrock. Mountains as we know them are carved by erosion out of areas uplifted by mountain building forces. These areas start as broad uplands. They are rapidly cut into by streams that erode deep valleys with steep walls. In time, the steep valley walls and high surrounding hills are worn down, leaving wider valleys with gentle slopes winding among low hills. With still more time, only hillocks separated by wide valleys with slow-moving, meandering streams are left and, given enough time, even the hillocks would be worn away.

In British Columbia, glacial ice played a leading role in shaping the land and in depositing sediments (*see* Glacial History Section). However, since the ice melted back, streams have again dominated erosion.

Bedrock also has a strong effect on landforms. The hardness, whether the rock dissolves in water, whether there are alternating hard and soft zones, whether rocks are cracked or massive, and other factors are important. For example, granites are often cracked in rectangular patterns, so streams crossing them tend to form rectangular patterns of valleys. If hard sandstone is interlayered with soft shale, there will likely be high standing sandstone ridges and shale valleys. Climate plays a role too. In the dry belt, limestone erodes very slowly and often forms cliffs, but in wet areas, it tends to dissolve and be low-lying. The mix of glaciation, weather, rock types, rock structures, and relief combine to create an amazing variety of landforms.

There are four general topographic divisions of the Province. These are the Western, Central, and Eastern Systems, and the Alberta Plains. The Western System includes high mountain ranges along the coast of British Columbia, as well as the mountain ranges of Vancouver Island and the Queen Charlotte Islands. The Eastern System is made up of the Rocky Mountains and their foothills. In between, the Interior System consists of plateaus, low basins, highlands, and rugged mountains.

The Western System actually consists of two mountain chains, the Outer Mountains and the Coast Mountains, separated by the Coastal Trough. By geological standards the speed of uplift and removal of the covering rocks in this system has been spectacular. Less than 10 million years ago, volcanic and granitic rocks that now form high peaks in the Coast Mountains were several kilometres under the surface.

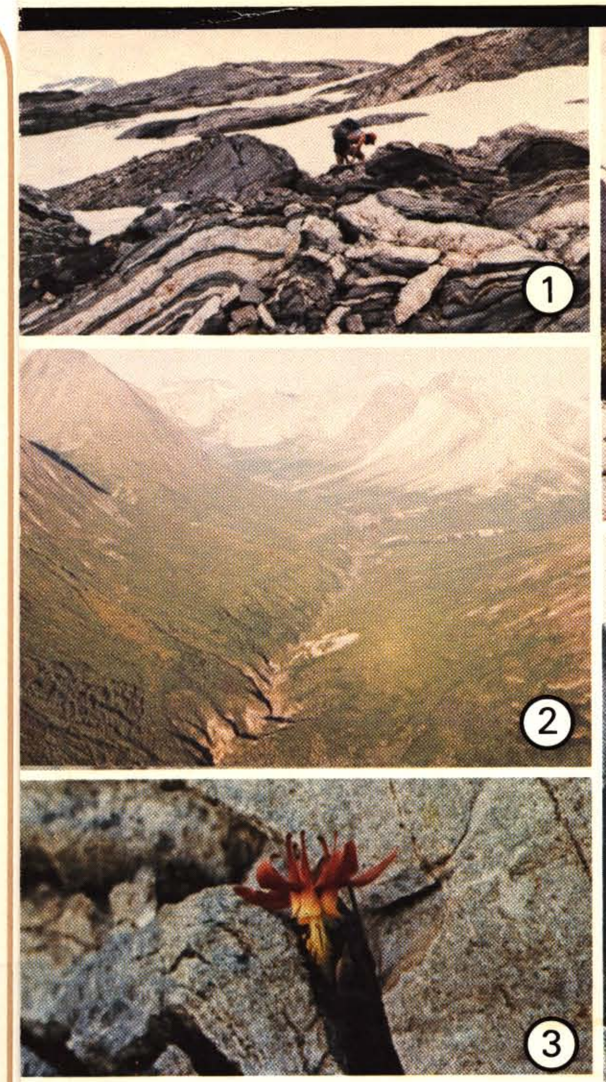
The picture in the Eastern System is quite different. It consists of the Rocky and Mackenzie Mountains and is bounded on the west by the Rocky Mountain Trench. Granitic rocks are uncommon; instead the rock record shows incredible piling up of slabs of rocks that were pushed and slid in from the west. This created thick piles of sedimentary rocks but the piling up disturbed normal sequences. That is, old rocks now lie above young rocks and unrelated rocks can be side by side.

The movements that originated parts of the Eastern System started about 150 million years ago, back in the Jurassic era. However, most of it took place between 100 and 40 million years ago, that is, from Late Cretaceous to Early Tertiary time. What we now see as the bounding Rocky Mountain and Tintina trenches formed about 20 million years ago in Miocene time, at the same time as basalt flooded out onto plateau surfaces in the Central System.

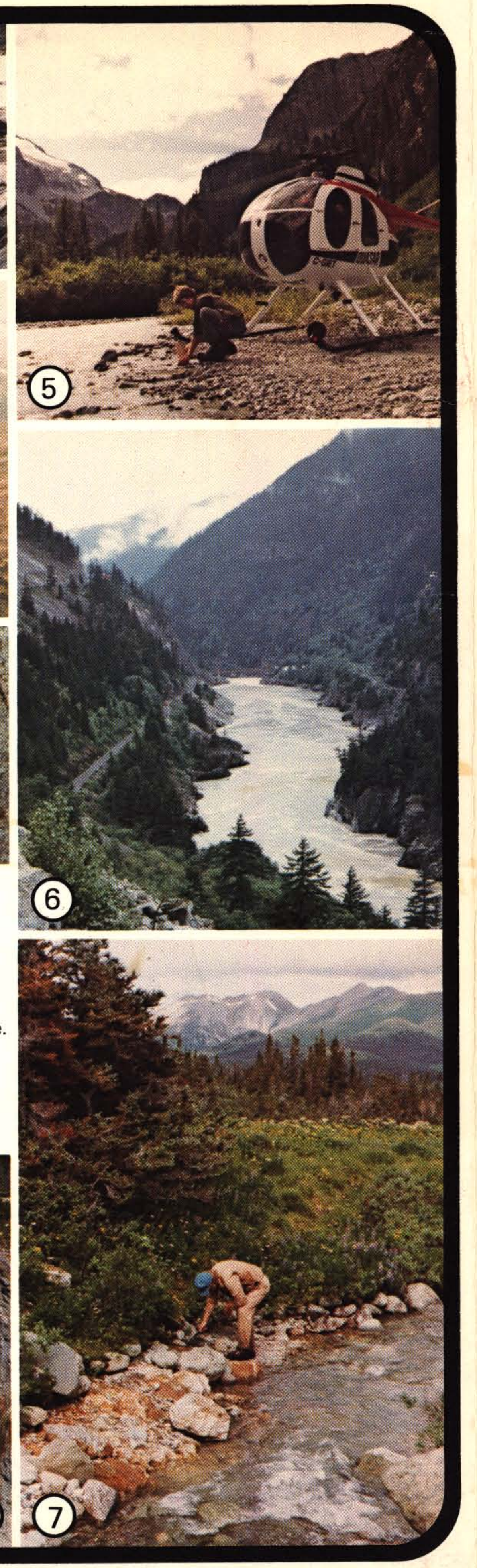
The rugged grandeur of the eastern Rocky Mountains reflects the nature of the rocks that compose them. Most of the mountains are northwesterly trending and are made up of bent and broken but still erosion-resistant rocks. Deep valleys that separate them were cut into softer, less resistant rocks.

The Central System is a mix of plateau and mountain areas with a complex history that began more than 200 million years ago and continued into the Ice Age. For example, basalts south of Ashcroft are 200 million years old, those near Spences Bridge 100 million years old, but valley-fill basalts near Merritt are only half a million years old and poured out onto glacial sediments.

The Central System is broken into three segments; each consists of a plateau area on the west and a mountainous area on the east. The mountainous areas are underlain by old rocks, including igneous, metamorphic, and Precambrian sedimentary rocks. The plateaus are formed, for the most part, of younger rocks.



1. Mapping pegmatite–laced amphibolitic gneisses near Revelstoke.
2. River incised into U - shaped Scud River valley, a tributary of the Stikine River.
3. Columbine rooted in folded calc silicate gneiss near Revelstoke.
4. Folds in metamorphic rocks, Mica damsite.
5. Stream silt sampling near Pemberton.
6. Hells Gate canyon at Alexandria Bridge.
7. Prospecting rusty gossan in Kutcho Creek area, north central B.C.



BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAP

GENERALIZED GEOLOGY
LEGEND

- Intrusive igneous rock – chiefly Late Mesozoic
- Flat lying lava, and some sedimentary rocks – Cenozoic
- Flat or gently dipping sedimentary rocks – Cretaceous and younger
- Folded sedimentary rocks – Paleozoic and Proterozoic
- Folded and faulted volcanic and sedimentary rocks – chiefly Mesozoic
- Foliated metamorphic rocks

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

MAP 3

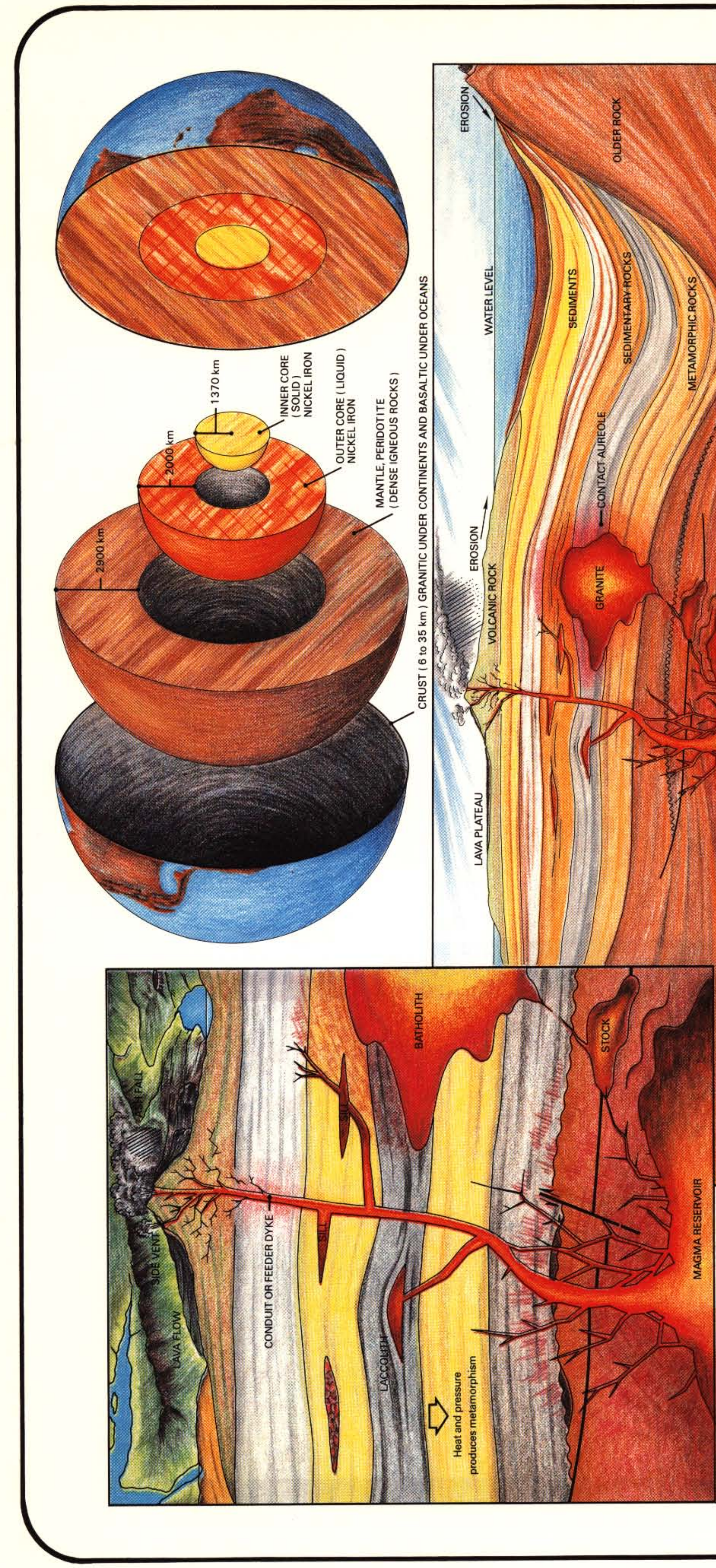


FIGURE 5
GEOLOGICAL CYCLE ILLUSTRATED

LEGEND

TIME (MILLION YEARS)		SEDIMENTARY ROCKS: MAINLY SHALE, SANDSTONE, SILTSTONE, CONGLOMERATE	SEDIMENTARY ROCKS: MAINLY LIMESTONE, DOLOMITE	VOLCANIC ROCKS: MAINLY ANDESITE, BASALT, RHYOLITE
	CENOZOIC			
	QUATERNARY			
	PLEISTOCENE AND RECENT (GLACIAL DEPOSITS, DRIFT)	Q		
– 1.0 –	**UPPER TERTIARY AND QUATERNARY**			
	MIOCENE AND LATER (PLATEAU BASALTS, UNDEFORMED VOLCANIC PILES)			uTQ
– 22.5 –	**TERTIARY**	T		
	LOWER TERTIARY			
	PALEOCENE TO OLIGOCENE (omT – INCLUDES SOME MIOCENE)			lT
– 65 –	**MESOZOIC**			
	CRETACEOUS (KT – INCLUDES SOME TERTIARY)	K KT		K KT
– 143 –	**JURASSIC** (JK – INCLUDES SOME CRETACEOUS)	J JK		J JK
– 205 –	**TRIASSIC** (TRJ – INCLUDES SOME JURASSIC)	TR TRJ	TR	TR TRJ
– 245 –	**UPPER PALEOZOIC**			
– 365 –	**MIDDLE DEVONIAN TO PERMIAN** uP, uPTR, D, DP, DTR, DJ, C, CP, M, MP, MTR, PP, P, PTR			
	LOWER PALEOZOIC			
– 575 –	**CAMBRIAN TO LOWER DEVONIAN** lP, l€, €, €D, €O, O, S, SD, D			
	PROTEROZOIC			
– 1000 –	**HADRYNIAN (WINDERMERE)** (HC – INCLUDES SOME CAMBRIAN) (HD – INCLUDES SOME DEVONIAN)	H	H	
– 1700 –	**HELIKIAN (BELT – PURCELL)**	H	H	

UNDIFFERENTIATED METAMORPHIC ROCKS

INTRUSIVE ROCKS

MAINLY GRANITE, GRANODIORITE, DIORITE

TIME (MILLION YEARS)		
		CENOZOIC
– 30 –	MLT	MIDDLE TO LATE TERTIARY
		LATE MESOZOIC – CENOZOIC
– 80 –	KT	LATE CRETACEOUS TO EARLY TERTIARY
		MESOZOIC
– 143 –	K	EARLY TO LATE CRETACEOUS
– 195 –	J	MIDDLE TO LATE JURASSIC
– 245 –	TRJ	LATE TRIASSIC TO EARLY JURASSIC
		PALEOZOIC
– 575 –	P	
		PROTEROZOIC
– 1700 –	P	

MESOZOIC AND TERTIARY

MT — COAST RANGE PLUTONIC COMPLEX

LATE PALEOZOIC AND MESOZOIC

ULTRAMAFIC ROCKS

GEOLOGIC AGE SYMBOLS

Q	QUATERNARY	P	PENNSYLVANIAN	P	PALEOZOIC
m	MIOCENE	M	MISSISSIPPIAN	P	PROTEROZOIC
o	OLIGOCENE	D	DEVONIAN		
T	TERTIARY	S	SILURIAN		
K	CRETACEOUS	O	ORDOVICIAN		
J	JURASSIC	€	CAMBRIAN	u	upper
TR	TRIASSIC	H	HADRYNIAN	l	lower
P	PERMIAN	H	HELIKIAN	L	LATE
C	CARBONIFEROUS	M	MESOZOIC	M	MIDDLE

NOTE: uPTR means upper PALEOZOIC to TRIASSIC inclusive.

SYMBOLS

HIGHWAYS:
- ARTERIAL AND SECONDARY
- LOCAL

FERRY (ROUTE AND DISTANCE)

HOSPITAL

FAULTS: NORMAL

THRUST

GEOLOGICAL CONTACT

DISTANCE IN KILOMETRES — 29

BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAPS

Production Staff: Legend and Geological Compilation, E. V. Jackson.
Coordination and text, W. J. McMillan
Cartography, J. Armitage
Text production, R. Moir

Acknowledgment and financial support of the following two organizations is gratefully acknowledged:

Cordilleran Section,
Geological Association of Canada,
Vancouver, B.C.

Canadian Society of Petroleum Geologists,
Calgary, Alberta

Geology derived mainly from the following geological maps compiled by officers of the Geological Survey of Canada, 100 West Pender Street, Vancouver:

MAP NAME	COMPILED BY	OPEN FILE NO.	SCALE
Fraser River	A. V. Okulitch	165	1:1 million
Skeena River	A. V. Okulitch	166	1:1 million
Parsnip River	R. B. Campbell, *et al.*	261	1:1 million
Kootenay River	A. V. Okulitch and G. J. Woodsworth	481	1:1 million
Vancouver Island	J. E. Muller	463	1:250 000
Tectonic Assemblage Map of the Canadian Cordillera	H. W. Tipper, *et al.*	572	1:2 million
Geological Map of Part of the Southeastern Canadian Cordillera	R. B. Campbell	----	1:1 million

PLATE TECTONICS (FIGURE 8)

'Plate tectonics' is a new name hung on an old idea. The idea was first put forward in the 1920's when Wegener noticed that the edges of some of the continents look as if they fit together. He concluded that over long time spans continents are not fixed; they move about, collide, and split apart. He suggested that continents 'drift.' The idea was laughed at at the time but, although his mechanisms to explain the movement are discredited, the idea has so many lines of evidence to back it up that it is now accepted.

Over long periods of time oceans open and close and continents wander. The present explanation is that the earth consists of large, fairly rigid crustal 'plates' floating on the 'mantle.' Mantle pressures and temperatures are very high, so rocks there are like thick, gummy fluids. Temperatures and pressures in the crust are lower so rocks there are more rigid.

Very large currents, thousands of kilometres across, ooze upward from deep in the mantle toward the surface then turn and move along the bottom of the crustal plates before they cool and finally move down again. Earth currents are large but move very slowly, only a few centimetres a year; however, over millions of years continents riding on them can move large distances. The currents move up because material deep in the mantle is hotter and less heavy or dense than that near the surface. The less dense material is more buoyant so, like a log pushed under water, it bobs up toward the surface. Deflected by the base of the crust, it moves sideways, cools, becomes more dense, and eventually sinks again to complete the cycle. Today there are several of these so-called convection cells in action in the mantle. The locations of continents, the directions that they move relative to each other, and how they interact are all controlled by the underlying mantle currents. As you can imagine, when the current patterns change with time so do the surface patterns.

In a way, crustal plates behave like foam on a cup of coffee. As currents move up from the hotter bottom of the cup, they come up in the middle, split in two, move out toward the edge of the cup, then as they cool, sink again. The foam, like the crust, is dragged along, lumped together, and split apart by the convective currents.

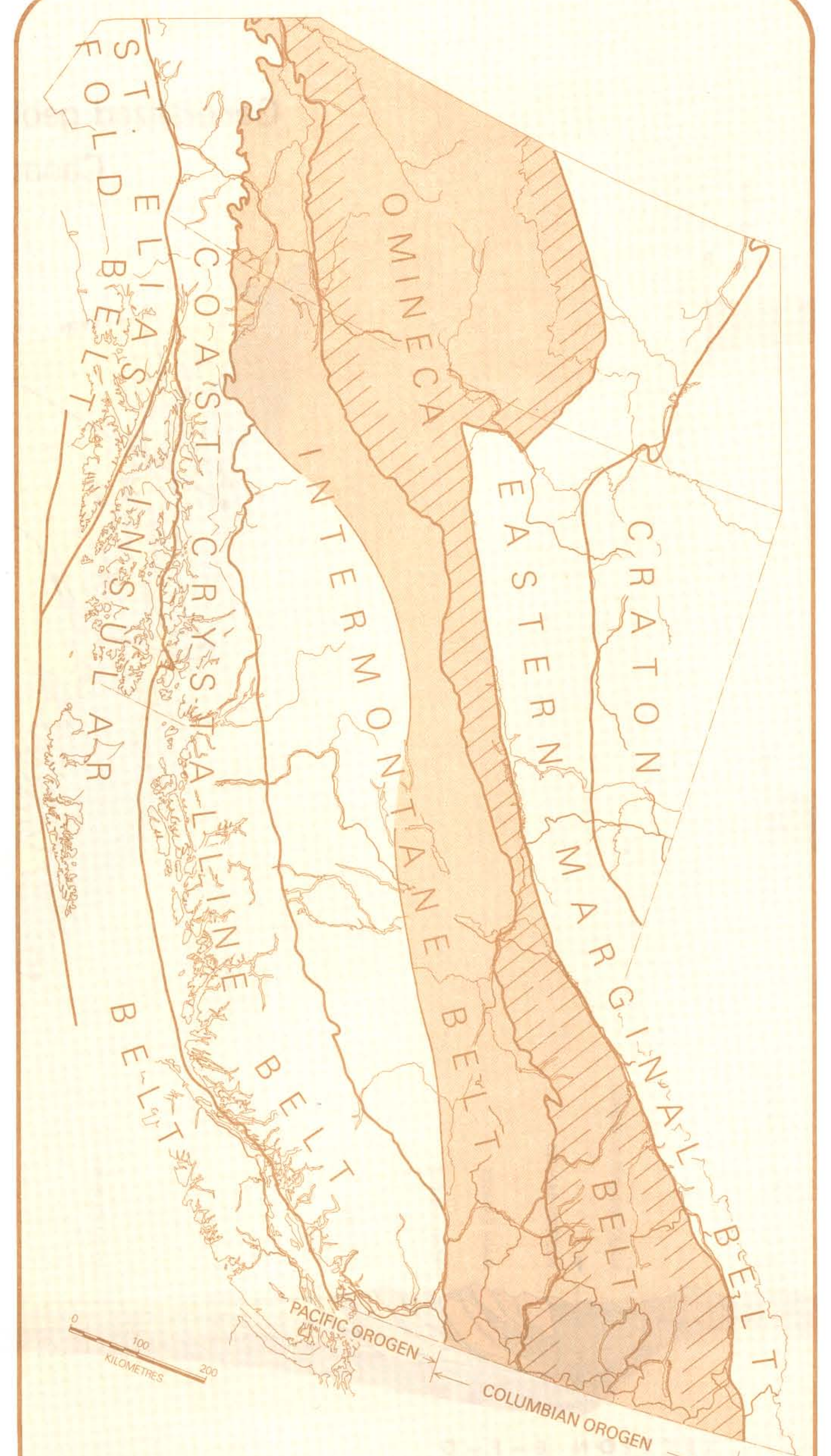
The currents affect the crust in different ways. Where they come up the crust tends to split and molten rock moves up from below to partly fill the opening. On Figure 8, the Mid-Atlantic Ridge, East Pacific Rise, and Mid-Indian Ocean Ridge are examples of such 'spreading centres.' If a spreading centre lasts for a long time, ocean basins are formed; for example, the present Atlantic Ocean began to open about 150 million years ago.

Where currents descend, the relative buoyancies of overlying crustal plates control the results. The crust under oceans is thinner but heavier or denser than that under continents. Oceanic crust averages 10 kilometres in thickness whereas continental crust averages 35 kilometres. Where oceanic crust collides with continental crust, the currents drag the denser, oceanic crust down under the lighter, more buoyant continental crust. As it is dragged down along the 'subduction zone,' the oceanic crust causes earthquakes and, as it gets deeper, begins to melt. The result is a line of volcanos about 150 kilometres inland from the deep trench on the ocean floor that marks the point where the oceanic slab started to dive under the continental crust. The Andes Mountains of South America, volcanos along the Alaskan coast, and, closer to home, the Cascade volcanos, including Mount St. Helens, are examples.

Where continental crust collides with continental crust, the crustal material is too light and buoyant to be dragged down along a subduction zone, so it piles up and crumples instead. In some cases, one side even gets pushed up over top of the other. This type of collision causes spectacular, high mountain ranges to form. The Himalaya Mountains, for example, formed and are continuing to form because the plate for India is colliding with the plate for Asia. Our own Coast Range may have formed in the same way.

Sometimes, instead of collisions, the currents cause crustal plates to slide alongside one another. Plate edges of this kind are marked by large-scale breaks or faults with hundreds or even thousands of kilometres of offset along them, like the huge San Andreas fault whose associated earthquakes cause so many problems in California. Off British Columbia, similar faults lie off the west coasts of Vancouver Island and the Queen Charlotte Islands.

Ideas stemming from the theory of plate tectonics forced us to re-think our interpretation of the geological evolution of the Cordillera. In British Columbia, many ancient plate tectonic events are written into the rock record; collisions, rifting, and sliding are all recorded.



TECTONIC REGIMES OF BRITISH COLUMBIA
FIGURE 9

A GEOLOGICAL TOUR IN TIME

Let's take a geological trip back in time. It's hard to imagine tremendous changes in the areas where we live; geological processes are mostly too slow for us to notice them. Most take hundreds or thousands of years to show. For example, fast plate motions are a few centimetres a year!

For the trip, let's imagine ourselves high above British Columbia watching the panorama of changes as we voyage in our time machine. At first we thought of looking at changes as we traveled back in time, but that would be like watching a movie run backward. Instead, let's go back 1 000 million years and then travel back to our own time and watch events in the sequence in which they occurred. Even with our most modern machine we can travel only 10 000 years per second, so the trip will take 100 000 seconds or about 28 hours each way.

We've arrived at an exciting time. We know from our geological history books that up until now British Columbia was open ocean. Now, at 1 000 million years we see in the southeast that there are new islands forming as great blocks of land are jumbled along faults. Sediments are shedding east off them and dark lavas ooze up along the faults and pour out onto the surface. It's too hazy to see what is happening elsewhere so let's move on.

The mountains have pretty well worn down here at 900 million years but the shoreline is continuing to creep westward.

Ten hours of travel and the only break from this boring seascape are the carbonate banks that bloom and wither periodically along the coastline. Let's give it one more hour then stop and take a closer look. Ah, here we are at 575 million years before present. Still looks much the same but wait, there's something new; there are all kinds of marine creatures with protective shells down there. We've entered the Paleozoic era.

Another quick stop five hours later in the Middle Paleozoic at 380 million years before present. The ocean vista is now broken by a string of volcanic islands in the south, but otherwise little has changed. Wait, I see some strange armoured fish and there are graptolites everywhere with fronds trailing below their float sacs — life forms have evolved significantly. Enough of the Paleozoic, let's move on to the beginning of the Mesozoic.

This is more like it. Here at 230 million years there's a chain of volcanic islands inboard from a deep trough marking a subduction zone that runs northwestward for several thousand kilometres. Sediments are still being transported westward off the Canadian Shield and extensive carbonate reefs mark the eastern shoreline. I even see a few land animals on some of the islands! We'll stop again in 15 minutes at 210 million years and take another look.

The ocean now abounds with crawling and swimming nautiloid-like ammonites and other strange creatures. Wow, there's an ichthyosaurus, it looks like a huge porpoise, but what teeth! This is interesting, let's move on for another 10 minutes and see what changes.

Some very strange things are happening. While we were enroute a huge area of volcanic islands hove into view in the south. Apparently plate motions are sliding them northward to collide with the Cordillera! Judging from the life forms, especially the fusulinids, some of the limestone bodies and reefs on the islands formed near the equator!

The trench appears to have shifted off to the west, almost to its modern position. While we were travelling, an ocean opened up to the north; the view is a bit hazy but it seems to be almost closed again now. Over to the east, a big welt of land has squeezed up to begin to form the Omineca Belt; there must be terrible subterranian convolutions and metamorphosis going on in the buried rocks. Further east, great slabs of rock have begun to slide off the Omineca Belt and be thrust eastward over top of the sediments and rocks that were laid down along the edge of the craton. To the southwest, volcanic island arcs dot the sea; to the northwest, erosion is rapidly wearing down newly emerged land areas and dumping sediments into adjacent basins. Many of the areas are treed with large, exotic ferns and conifers. Time for us to move on.

At 100 million years land patterns are becoming familiar. Over to the east activity in the Omineca Belt has continued and embryonic Rocky Mountains have formed. East of them, there is a broad swampy floodplain then a shallow inland sea. The plant life is incredibly abundant, no wonder dinosaurs abound in this area and it eventually became the Southeast Coalfield. Northward, the setting is similar but there is an extensive embayment in the sea so that the coastline north of the future Northeast Coalfield runs east-west; wonder what caused that? The size and ferocity of some of the dinosaurs make us appreciate our safe vantage point!

As we travel forward in time, land areas become more numerous. At 70 million years, only two hours travel time from home, most of the central and eastern parts of the Province are continental. Swampy areas have verdant growth but the trees and plants, while still exotic, are more like modern tropical plants now.

A GEOLOGICAL TOUR IN TIME *(CONTINUED)*

Continuing, between 70 and 20 million years the subduction zone off the west coast remains but we watch several hundred kilometres of sliding movement take place along major faults that now underlie parts of the Fraser — Yalakom River drainage, the northern Rocky Mountain Trench, and the Tintina Trench. These grinding, slipping movements severely deform adjacent rocks. Those near the faults are torn apart and great blocks founder to form deep valleys. In the east, sheet after sheet of rocks slide and are thrust eastward to form the Rocky Mountains. Immense volumes of lava pour out in the Intermontane Belt as it is ripped asunder. Further west, huge volumes of melted rock are generated by subduction and faulting and, as they are emplaced in the roots of what is now the Coast Ranges, a great welt of land rises above them. With the increased rainfall that the new highland causes, erosion is incredibly fast but the mountains do not wear down! Their rate of uplift must be very high. The new mountains have also created a semi-desert to the east and new life forms are moving in to take up residence.

As the timer dial passes the 20 million year mark, half an hour from our journey's end, the tectonic scene shifts. Now, a great rift has appeared in the oceanic crust off the northwest coast of Vancouver Island. The oceanic crust south of the rift is still moving slowly toward and being subducted under the coast but that to the north is ponderously marching northward to plunge under the Alaskan Peninsula. New basaltic lavas are welling up the rift zone onto the sea floor and volcanos spew inland from the subduction zones in northern Washington and adjacent British Columbia, and in Alaska. Further inland in Washington and along the length of central British Columbia are vast puddles of dark basaltic lavas. Things are pretty quiet over to the east.

As we continue onward toward our own time, the masses of land are now in familiar positions but the sizes of mountains and the coastline are different and the volcanos that blow apart periodically are frightening.

At 3 million years, about the time that man evolved in Africa, the climate is subtropical and pleasant. At our present speed we've only five minutes more to travel. Let's slow down a little so we don't miss all the action.

What are those white areas in the mountains? It's getting cooler, time to zip up our jackets. The white areas are getting bigger, moving down into the valleys. We must be watching the beginnings of the ice age! As the ice masses grow, they begin to fill all the valleys, to come together, and finally to cover the land almost entirely. As more and more water is trapped as ice, sea level drops. As we speed onward in time we watch the ice melt back, re-advance and melt back again. After many cycles, we see radical changes in the animals. To survive, the elephant-like creatures have grown huge tusks and long hair, they are now mammoths; there are musk-oxen and caribou but few other animals left.

Scientists tell us that the last great ice advance started to melt back about 15 000 years before present, so let's stop and have a look at its greatest development. Wow, the ice is covering just about everything! The waterways between the offshore islands and the mainland are filled and there is nearly a mile of ice above the site where Victoria will eventually be built. The great ice mass doesn't extend very far south into Washington and the rivers flowing south off the ice toe are immense! I'm chilly, let's get moving again.

The ice is melting back rapidly and is back almost to the present level by 12 000 years before present. The sea level is very high at 12 000 years but the land is rebounding after removal of the great weight of ice. At 5 000 years, the landscape is much as we know it but of course without the cities, highways, industries, and population that give the Province its present character.

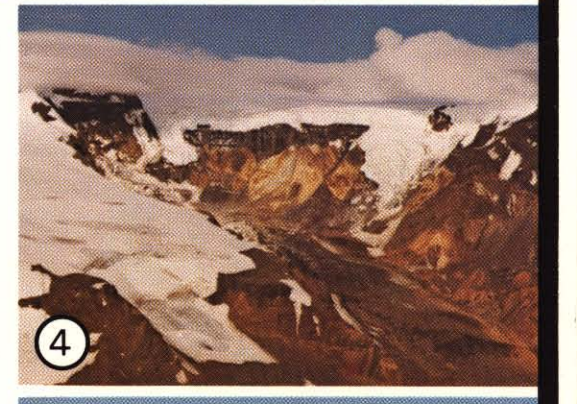
Here we are at last, back where we started in time. It's good to be home, even though we're boneweary from the trip. I set the dial to bring us back within a few minutes of when we started; just long enough for you to have read this narrative.

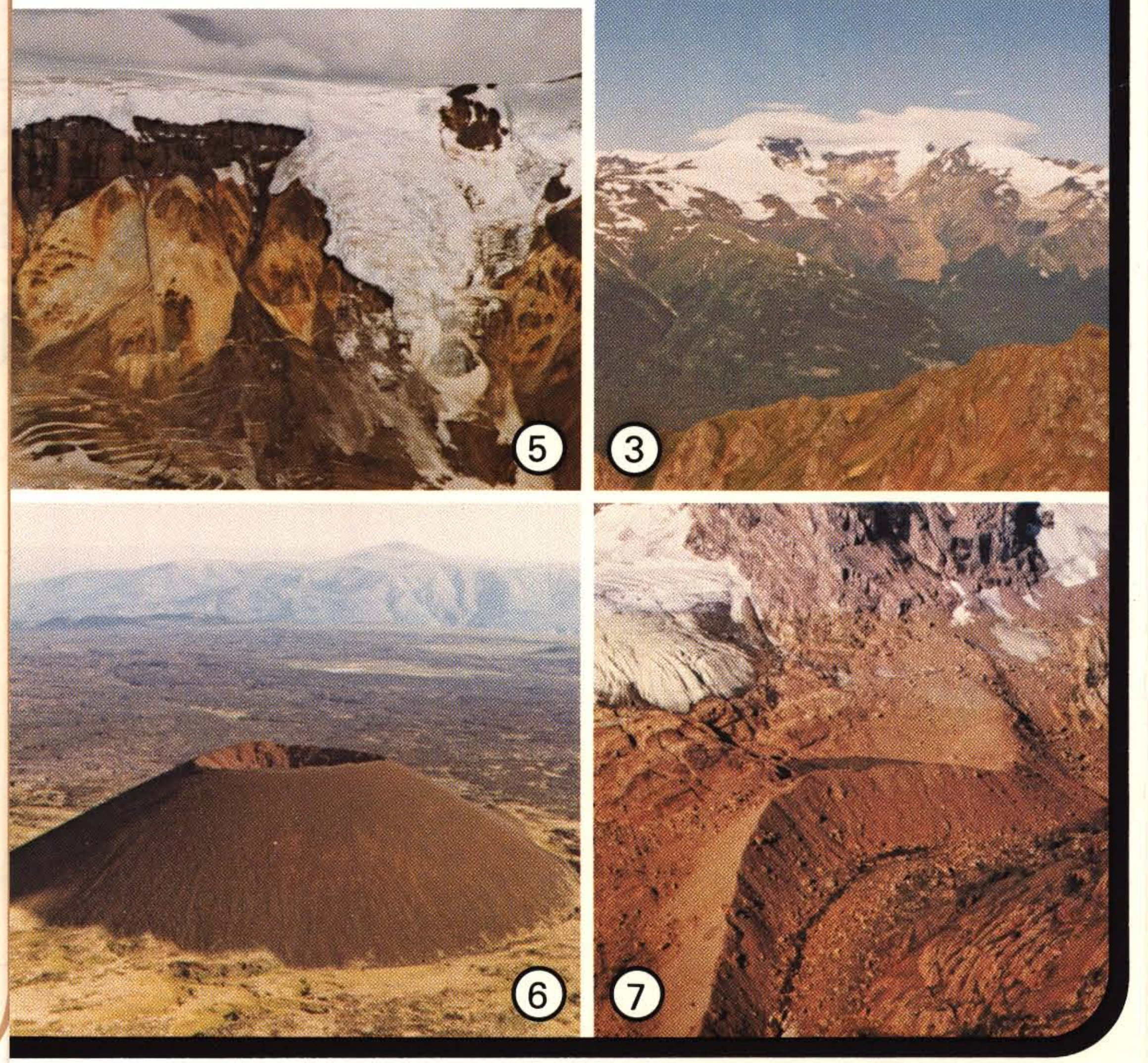
MAJOR FAULTS IN THE CANADIAN CORDILLERA

Major faults in the Canadian Cordillera run mainly northwest or northeast. As the figure shows, the faults form networks. They branch, come together or die out as you follow them along. Some are steeply inclined with up and down (normal or reverse) or horizontal (transverse or strike-slip) movement on them. Some, called thrust faults, are shallowly inclined. Movements on the faults can be anything from a few millimetres to thousands of kilometres. Those shown on the figure generally have offsets in the order of tens or hundreds of kilometres.

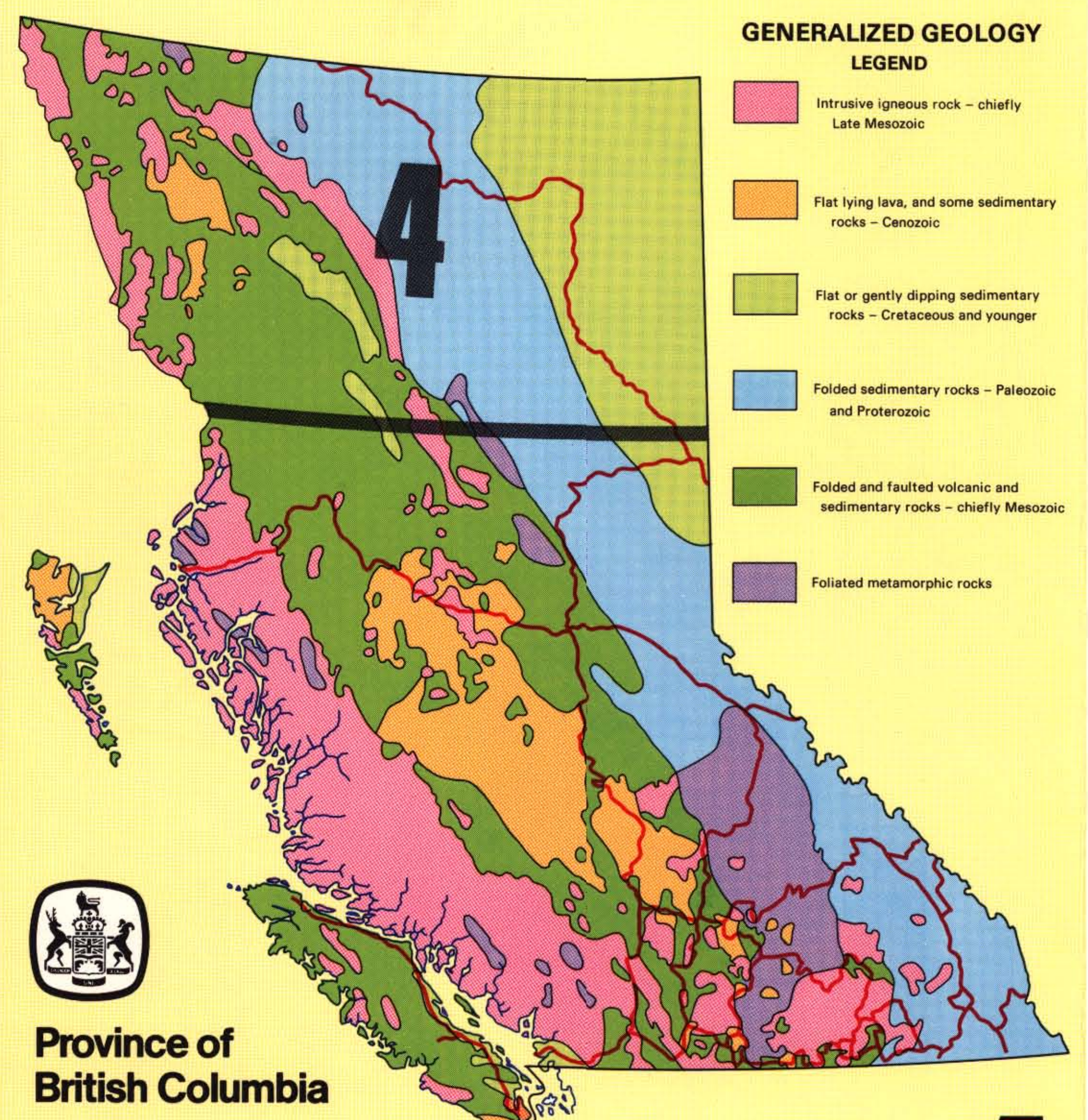
MAJOR FAULTS IN BRITISH COLUMBIA
FIGURE 10

1. Lava flows on N.E. flank of Mt. Edziza volcano.
2. Mt. Edziza volcano.
3. East side of Mt. Edziza volcano from about 10 km away.
4. Closer view of the east side of Mt. Edziza volcano.
5. In the throat of the volcano on the east side of Mt. Edziza.
6. Cinder cone on north plateau of Mt. Edziza volcano, looking north.
7. Ice melted back from debris pile (terminial moraine) shows extent of former ice advance, steeples, near Cranbrook.





BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAP



GENERALIZED GEOLOGY
LEGEND

- Intrusive igneous rock – chiefly Late Mesozoic
- Flat lying lava, and some sedimentary rocks – Cenozoic
- Flat or gently dipping sedimentary rocks – Cretaceous and younger
- Folded sedimentary rocks – Paleozoic and Proterozoic
- Folded and faulted volcanic and sedimentary rocks – chiefly Mesozoic
- Foliated metamorphic rocks

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

MAP 4

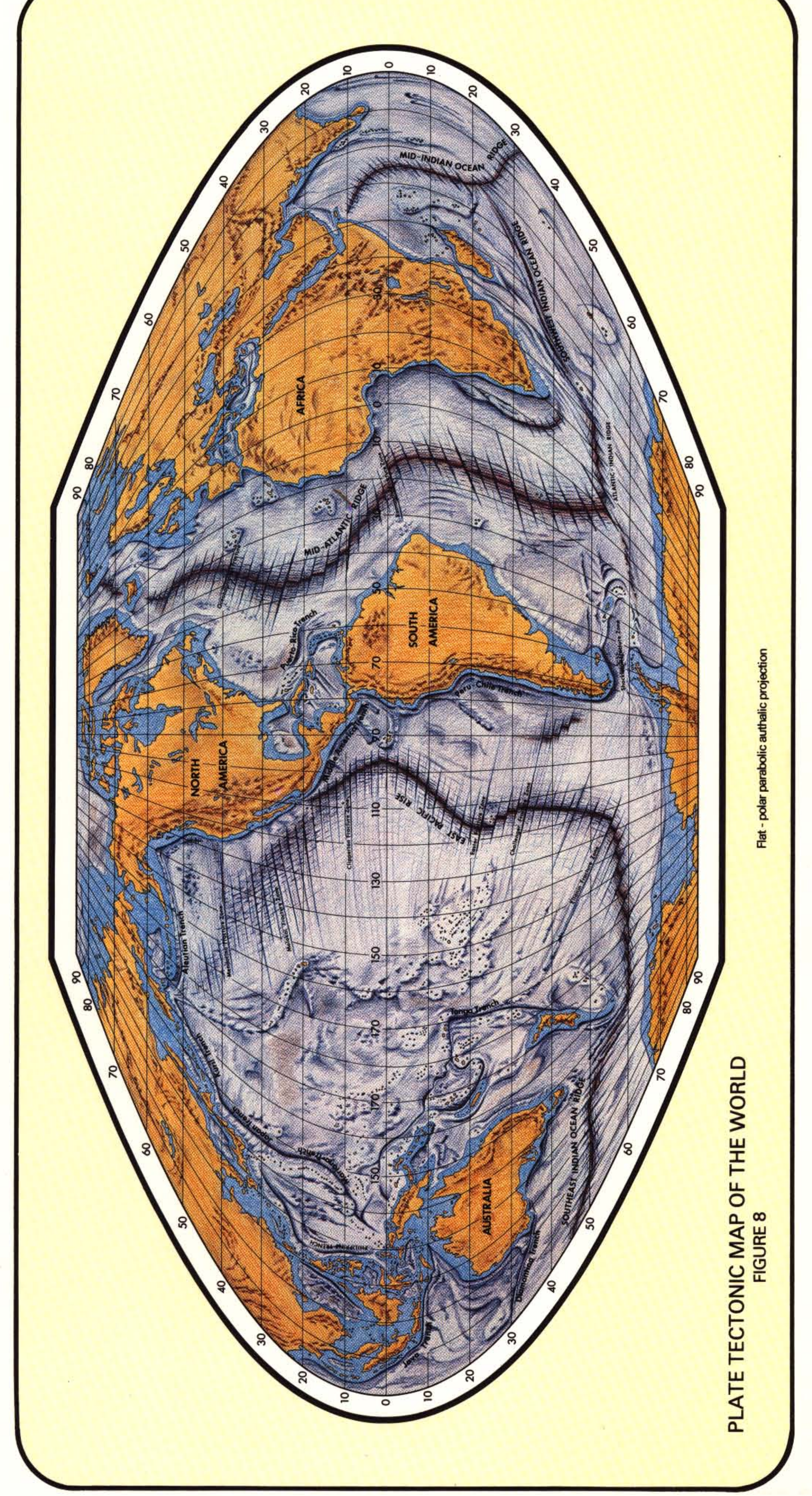


PLATE TECTONIC MAP OF THE WORLD
FIGURE 8

LEGEND

TIME (MILLION YEARS)		SEDIMENTARY ROCKS: MAINLY SHALE, SANDSTONE, SILTSTONE, CONGLOMERATE	SEDIMENTARY ROCKS: MAINLY LIMESTONE, DOLOMITE	VOLCANIC ROCKS: MAINLY ANDESITE, BASALT, RHYOLITE
	CENOZOIC			
	QUATERNARY			
	PLEISTOCENE AND RECENT (GLACIAL DEPOSITS, DRIFT)	Q		
– 1.0 –	UPPER TERTIARY AND QUATERNARY			
	MIOCENE AND LATER (PLATEAU BASALTS, UNDEFORMED VOLCANIC PILES)			uTQ
– 22.5 –	TERTIARY	T		
	LOWER TERTIARY			
	PALEOCENE TO OLIGOCENE (OMT – INCLUDES SOME MIOCENE)			lT
– 65 –	**MESOZOIC**			
	CRETACEOUS (KT – INCLUDES SOME TERTIARY)	K KT		K KT
– 143 –	JURASSIC (JK – INCLUDES SOME CRETACEOUS)	J JK		J JK
– 205 –	TRIASSIC (TrJ – INCLUDES SOME JURASSIC)	Tr TrJ	Tr	Tr TrJ
– 245 –	**UPPER PALEOZOIC**			
– 365 –	MIDDLE DEVONIAN TO PERMIAN uP, uPTr, D, DP, DTr, DJ, C, CP, M, MP, MTr, PP, P, PTr			
	LOWER PALEOZOIC			
– 575 –	CAMBRIAN TO LOWER DEVONIAN lP, l€, €, €D, €O, O, S, SD, D			
	PROTEROZOIC			
– 1000 –	HADRYNIAN (WINDERMERE) (HC – INCLUDES SOME CAMBRIAN) (HD – INCLUDES SOME DEVONIAN)	H	H	
– 1700 –	HELIKIAN (BELT – PURCELL)	H	H	

UNDIFFERENTIATED METAMORPHIC ROCKS

INTRUSIVE ROCKS

MAINLY GRANITE, GRANODIORITE, DIORITE

TIME (MILLION YEARS)		
		CENOZOIC
– 30 –	mlT	MIDDLE TO LATE TERTIARY
		LATE MESOZOIC – CENOZOIC
– 80 –	KT	LATE CRETACEOUS TO EARLY TERTIARY
		MESOZOIC
– 143 –	K	EARLY TO LATE CRETACEOUS
– 195 –	J	MIDDLE TO LATE JURASSIC
– 245 –	TrJ	LATE TRIASSIC TO EARLY JURASSIC
		PALEOZOIC
– 575 –	P	
		PROTEROZOIC
– 1700 –	P	

MESOZOIC AND TERTIARY

MT — COAST RANGE PLUTONIC COMPLEX

LATE PALEOZOIC AND MESOZOIC

ULTRAMAFIC ROCKS

GEOLOGIC AGE SYMBOLS

Q	QUATERNARY	P	PENNSYLVANIAN	P	PALEOZOIC
m	MIOCENE	M	MISSISSIPPIAN	P	PROTEROZOIC
o	OLIGOCENE	D	DEVONIAN		
T	TERTIARY	S	SILURIAN		
K	CRETACEOUS	O	ORDOVICIAN		
J	JURASSIC	€	CAMBRIAN	u	upper
Tr	TRIASSIC	H	HADRYNIAN	l	lower
P	PERMIAN	H	HELIKIAN	l	LATE
C	CARBONIFEROUS	M	MESOZOIC	M	MIDDLE

NOTE: uPTr means upper PALEOZOIC to TRIASSIC inclusive.

SYMBOLS

HIGHWAYS:
ARTERIAL AND SECONDARY
LOCAL
FERRY (ROUTE AND DISTANCE)
HOSPITAL
FAULTS: NORMAL
THRUST
GEOLOGICAL CONTACT
DISTANCE IN KILOMETRES 29

BRITISH COLUMBIA GEOLOGICAL HIGHWAY MAPS

Production Staff: Legend and Geological Compilation, E. V. Jackson.
Coordination and text, W. J. McMillan
Cartography, J. Armitage
Text production, R. Moir

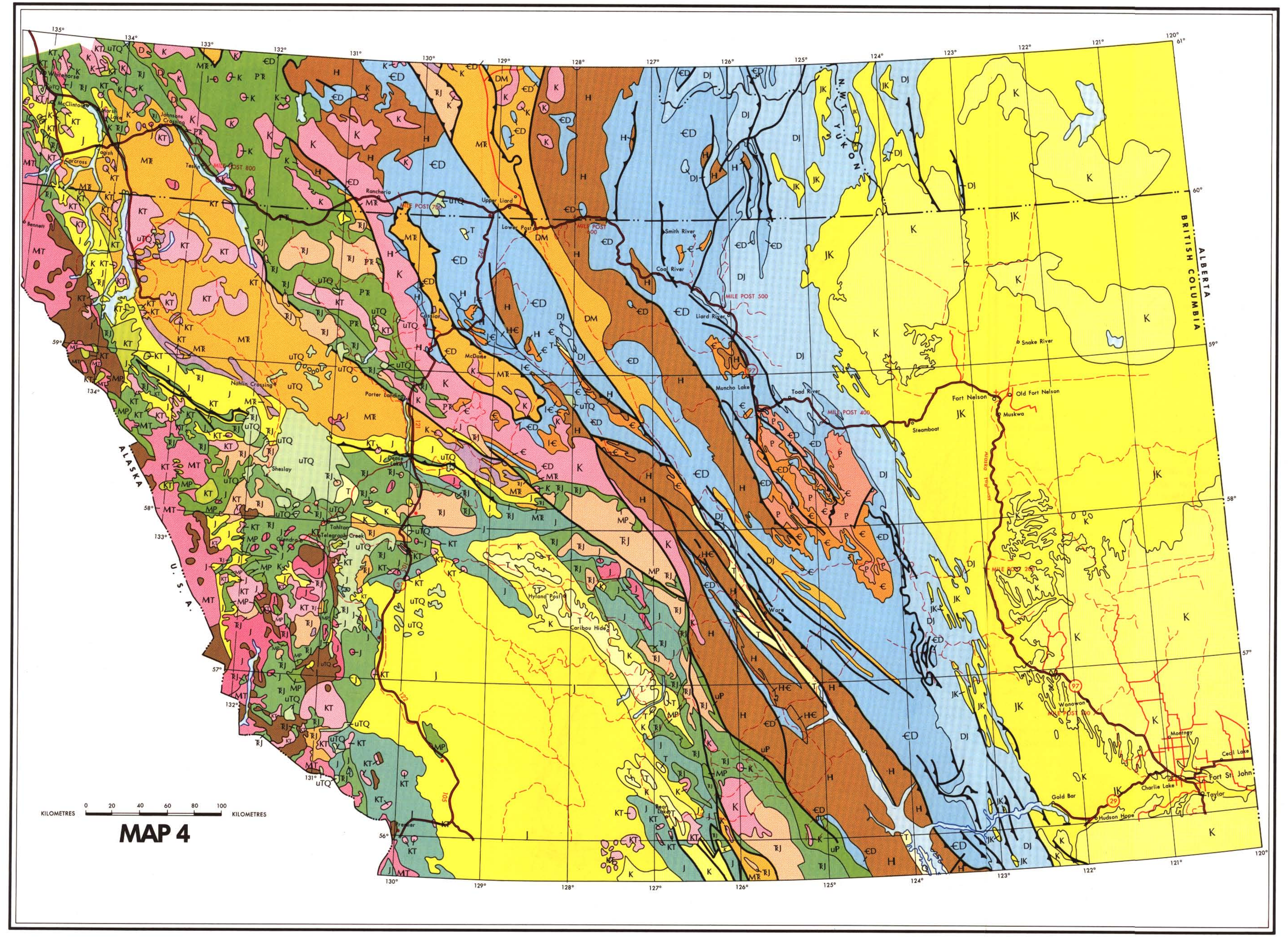
Acknowledgment and financial support of the following two organizations is gratefully acknowledged:

Cordilleran Section,
Geological Association of Canada,
Vancouver, B.C.

Canadian Society of Petroleum Geologists,
Calgary, Alberta

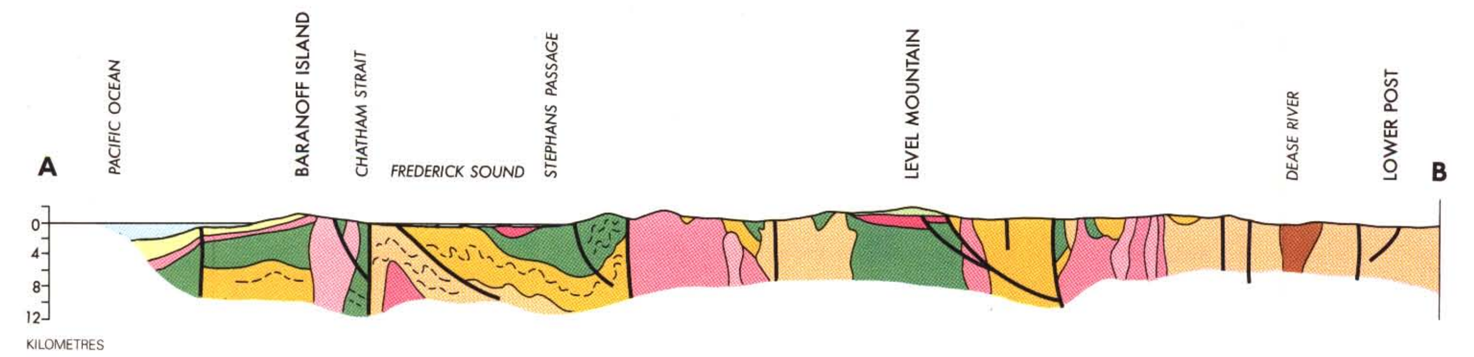
Geology derived mainly from the following geological maps compiled by officers of the Geological Survey of Canada, 100 West Pender Street, Vancouver:

MAP NAME	COMPILED BY	OPEN FILE NO.	SCALE
Fraser River	A. V. Okulitch	165	1:1 million
Skeena River	A. V. Okulitch	166	1:1 million
Parsnip River	R. B. Campbell, *et al.*	261	1:1 million
Kootenay River	A. V. Okulitch and G. J. Woodsworth	481	1:1 million
Vancouver Island	J. E. Muller	463	1:250 000
Tectonic Assemblage Map of the Canadian Cordillera	H. W. Tipper, *et al.*	572	1:2 million
Geological Map of Part of the Southeastern Canadian Cordillera	R. B. Campbell	----	1:1 million

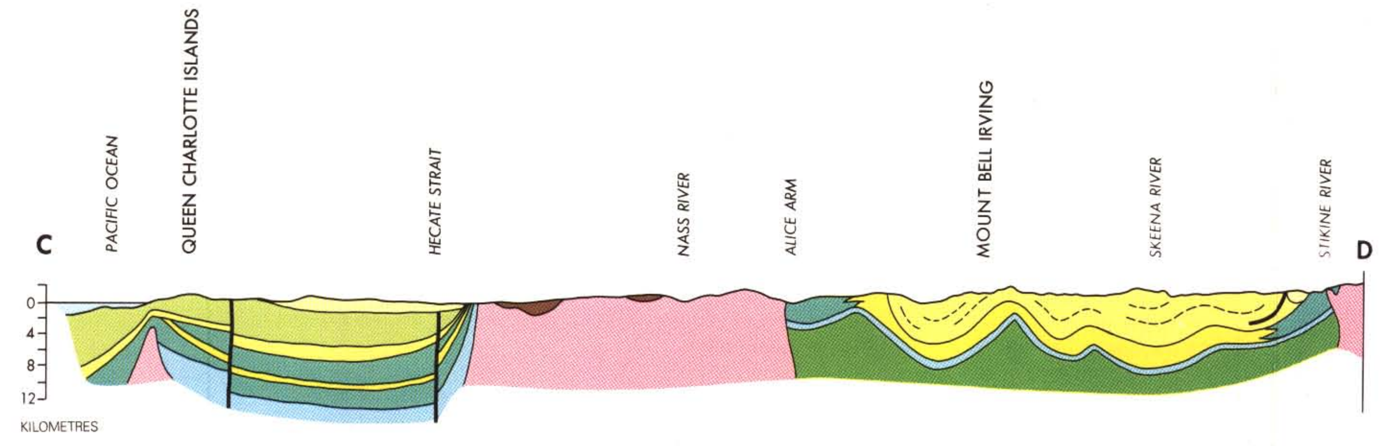


MAP 4

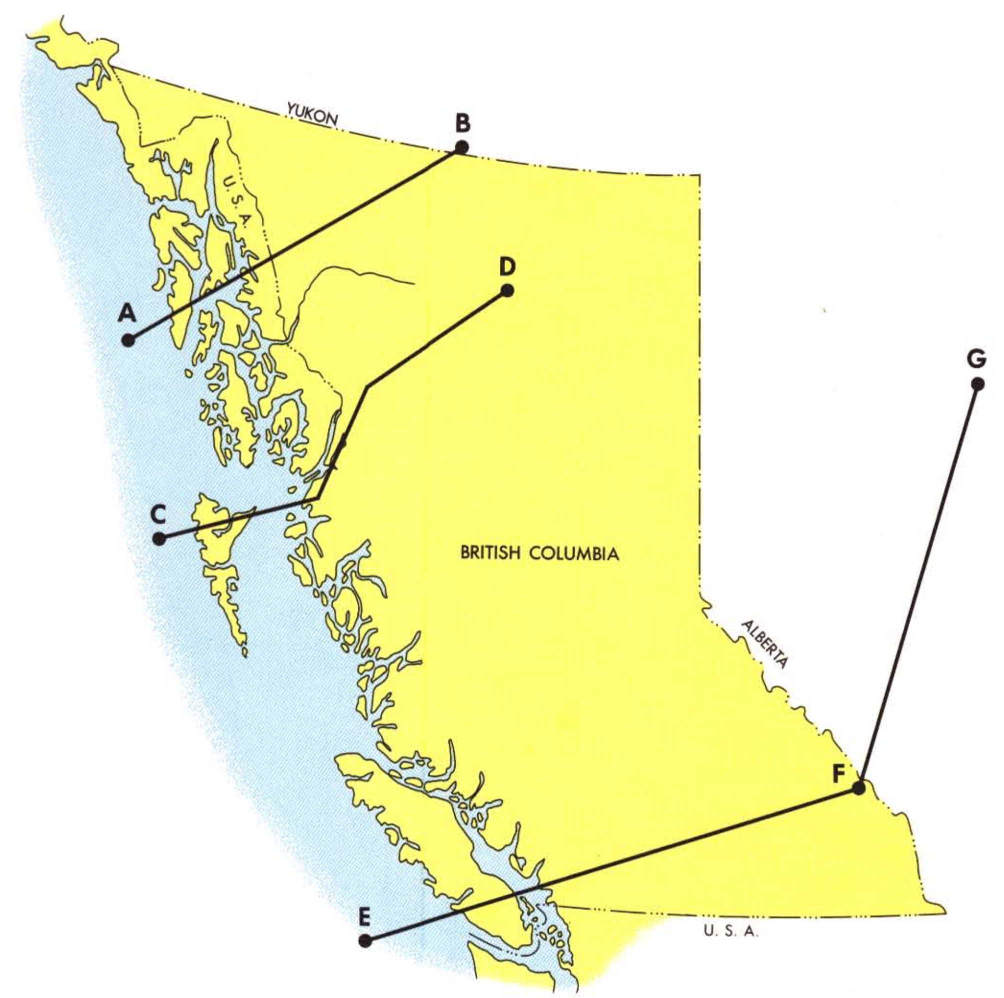
Generalized geologic cross-sections of the Canadian Cordillera



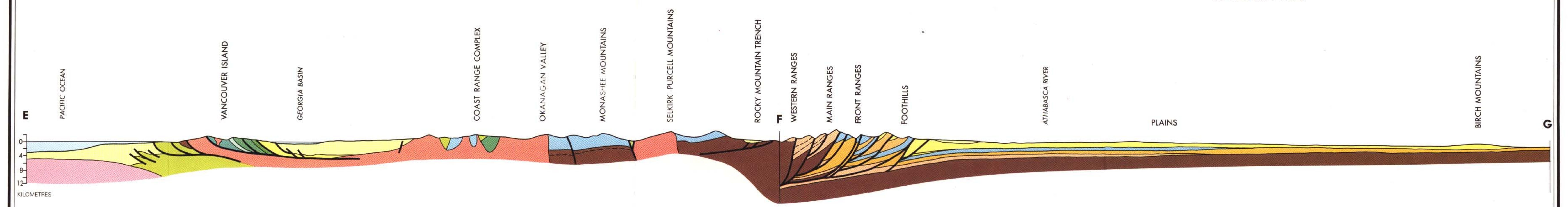
SECTION A–B



SECTION C–D



LOCATION MAP



SECTION E–F–G