APPENDICES

LIST OF APPENDICES

Table 5. LIST OF ROCK SAMPLES

Geological Index

Sedimentary rocks		Igneous rocks			
Quarternary (gravel & sand)	QU	Tertiary	Volcanic Breccia	TV
Merced Formation	ME		Monzonite porphyry	TM
Contamana Group	CO		Rhyolite & Dacite	TR
Huayabamba Group	HU		Quartz-porphyry & Granite porphyry	MP
Vivian Formation	VI			
Chonta Group	CH	Cretaceous	Granite	CG
Oriente Group	OR	Jurassic	Diorite complex	MD
Sarayaquillo Formation	SA	Permian - Triassic	Granite & Granodiorite	PG
Pucara Group	PU		Granodiorite complex	PC
Mitu Group	MI			
Copacabana - Tarma Group	TA			
Ambo Group	AM			
Excelcior Group	EX			
Basement Complex (gneiss & schist)	BC			

(Samples of the Reconnaissance Area)

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Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
214	S003	18B	OR	Sandstone	○									
215	S004	18B	CK	Limestone	○								○	
216	S006	18B	CK	Shale	○									
217	S006	18B	CK	Shale	○									
218	S012	18B	FU	Dolomite				○					○	
219	S013	18B	FU	Crystalline Dolomite	○									
220	S014	18B	FU	Crystalline Dolomite	○	○	○	○					○	
221	S015	18B	FU	Limestone	○								○	
222	S017	18B	CK	Limestone	○								○	
223	S019	19B	MU	Coarse Sandstone	○									
224	S022	20B	MU	Banded Coarse Sandstone	○									
225	S027	12E	CK	Sandstone	○									
226	S030A	12E	TM	Microdiorite	○									
227	S030B	12E	TM	Hornblende Gneiss	○									
228	S031	9F	BC	Hornblende Gneiss	○									
229	B001	7D	TM	Diorite Porphyry	○				○	○				
230	B002	20D	MU	Sandstone	○									
231	B003	14C	FU	Limestone							○			
232	B004	20D	VI	Sandstone	○									
233	B005	20D	CK	Sandstone	○									
234	B006	20D	OR	Sandstone	○									
235	B009	20D	SA	Sandstone	○									
236	B012	19C	CK	Limestone	○								○	
237	B013	16B	FU	Limestone							○			
238	B014	16B	FU	Dolomite (Zebra)	○			○					○	
239	B015	15C	FU	Sandstone	○									
240	B018	14C	MU	Diorite	○									
241	B019	14C	MU	Dacite	○									

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
242	B020	14C	MI	Dacite	○									
243	B021	14C	MD	Diorite	○									
244	B022	14B	MD	Diorite	○									
245	B023	14B	BC	Muscovite Gneiss	○									
246	B024	14B	MD	Porphyrite	○									
247	B025	14B	MI	Conglomerate	○									
248	B026	15C	MI	Porphyrite	○									
249	B028-1	16B	FU	Dolomite (Zebra)	○			○					○	
250	B028-2	14C	FU	Dolomite (Zebra)	○			○					○	
251	B029	14D	VI	Sandstone	○									
252	B030	15C	FU	Limestone							○			
253	C002	20D	OR	Sandstone	○									
254	C004	19C	TM	Hornblende Andesite	○									
255	C006	19C	CH	Limestone	○						○		○	
256	C007	19C	VI	Sandstone	○									
257	C010	19C	TM	Diorite Porphyry	○									
258	C011	19C	MU	Siliceous Rock	○									
259	C013A	16A	FU	Dolomite (Zebra)	○	○	○	○					○	
260	C014	17B	FU	Dolomite (Zebra)	○			○					○	
261	C015	10D	FG	Granite Porphyry	○									
262	C017	17B	CH	Limestone	○								○	
263	C020	14C	FU	Fine Sandstone	○						○			
264	C021	13C	FU	Dolomite (Zebra)	○	○	○	○					○	
265	C022	13C	MI	Andesitic Lapilli Tuff	○									
266	C023	13D	MI	Shale	○									
267	C024	10D	FG	Microdiorite	○									
268	C025	12D	FG	Quartz Diorite	○									
269	C026	12D	MI	Andesitic Coarse Tuff	○									

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
270	C027	12D	MI	Andesitic Lapilli Tuff	○									
271	C028	11D	PG	Microdiorite	○				○	○				
272	C029	12D	MI	Andesitic Tuff	○									
273	C030	12D	MI	Welded Tuff	○									
274	C031	12D	MI	Welded Tuff	○									
275	C032	12D	MI	Dacitic Rock	○									
276	C033	12D	MI	Coarse Sandstone	○									
277	C034	12D	PU	Dolomite (Zebra)				○					○ ○	
278	A001	19B	PU	Dolomite (Zebra)	○			○					○ ○	
279	A002	19B	PU	Dolomite (Zebra)	○	○	○	○					○	
280	A005	19C	CM	Sandstone (Calcareous)	○									
281	A007	19B	MU	Mudstone								○		
282	A008	13B	PG	Gneissose Diorite	○									
283	A010	14B	MI	Conglomerate	○									
284	A011	14B	MI	Sandstone	○									
285	A013	14B	MI	Conglomerate	○									
286	A014	14B	MI	White rock	○									
287	A016	14B	PG	Schistose Diorite	○				○	○				
288	A017	14B	PG	Gneiss	○									
289	A018	14B	SC	Schist	○									
290	A019	13B	PG	Schistose Diorite	○									
291	A020	13B	PG	Gneissose Granite	○									
292	A023	14C	PU	Limestone (Pb)	○	○	○							
293	A024	14C	-	Copper Oxide		○	○							
294	A025	14C	PU	Limestone (Copper Oxide)	○	○	○							
295	A026	17E	CM	Limestone	○									
296	A027	17E	CM	Gypsum				○					○	
297	A028	17E	CM	Shale	○									

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
298	A029	17E	CN	Sandstone	○									
299	A033	15D	VI	Sandstone	○									
300	A034	15D	VI	Fine Sandstone	○									
301	A037	19B	TM	Diorite	○				○	○				
302	A038	15E	CN	Limestone							○			
303	D003	19B	PU	Tuffaceous Fine Sediment								○		
304	D004	19B	PU	Shale (Calcareous)	○									
305	D006	19B	PU	Limestone	○			○					○	
306	D009	19B	PU	Dolomite (Zebra)	○	○	○	○					○	
307	D012	19B	SA	Shale	○							○		
308	D017	18B	SA	Shale	○							○		
309	D029	17C	CN	Limestone	○									
310	D030	17C	CN	Sandy Conglomerate)	○									
311	D039	19E	MU	Mudstone	○							○		
312	D045	13E	CN	Limestone	○								○	
313	D058	13B	BC	Muscovite Schist	○									
314	D060	13B	FG	Granite	○									
315	D061	13B	FG	Granite	○									
316	D063	13B	-	Limonite		○	○							
317	D064	13B	BC	Schistose Rock	○									
318	D065	13B	BC	Microdiorite	○									
319	D066	13B	BC	Schistose Rock	○									
320	D069	13B	FG	Granitic Rock	○				○	○				
321	D073	13C	MD	Diorite	○									
322	D074	13C	MI	Andesitic Rock	○									
323	D075	13C	MD	Granite	○									
324	D079	13C	MD	Porphyritic Diorite	○				○	○				
325	D081	13C	MD	Microdiorite	○									

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
326	D082	13C	MD	Granitic Rock	○									
327	D086	13D	MD	Granitic Rock	○									
328	D087	13D	MD	Granitic Rock	○									
329	D089	13D	MI	Coarse Sandstone	○									
330	D020	18B	CH	Shale							○			
331	C003	20C	CH	Calcareous Sandstone									○	
332	C013B	16A	PU	Dolomite (Zebra)									○	
333	B027	15B	PU	Dolomitic Limestone									○	
334	D020	15A	PU	Limestone									○	
335	KN006	3F	PU	Dolomitic Limestone									○	
336	KN007	3F	PU	Crystalline Limestone									○	
337	KN095	6F	PU	Dolomite (Zebra)									○	
338	KN098	6F	PU	Sandstone									○	
339	KN099	6F	PU	Dolomitic Limestone									○	
340	KN100	6F	PU	Dolomitic Limestone									○	

(Samples of the Detailed Survey Area)

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Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
341	KE001	6	MF	Quartz porphyry	○									
342	KE002	6	MF	Quartz porphyry	○									
343	OE011	11	CG	Sphalerite bearing pegmatite			○							
344	KE012	10	CG	Micro diorite	○									
345	OE024	13	CM	Limonite gossan			○							
346	OE029	18	PU	Galena bearing limestone			○							
347	KE040	16	CM	Mudstone	○								○	
348	OE050	16	PU	Limonite gossan		○	○							
349	OE287	16	PU	Pb ore (Pichite calge mine)		○	○							
350	OE288	18	PU	Copper oxide (")		○	○							
351	PE289	18	PU	Zn ore (")		○	○							
352	OE290	16	CM	Limonite vein			○							
353	LE021	9	PU	Breccia dolomite				○					○	○
354	LE195	15	PU	" "				○					○	○
355	LE214	15	PU	Dolomitic limestone				○					○	○
356	LE242	16	CM	Grey limestone									○	
357	LE247	15	PU	Breccia dolomite				○					○	
358	LE254	15	PU	" "				○					○	○
359	LE268	16	CM	Grey limestone									○	
360	LE280	18	PU	Grey limestone									○	
361	KP006	4	PU	Light grey dolomite	○								○	
362	OP007	4	PU	Galena bearing limestone		○	○						○	
363	KP013	6	PU	Light grey dolomite	○								○	
364	KP015	6	PU	Crystalline dolomite	○								○	
365	KP016	6	PU	Dark grey limestone	○								○	
366	OP017	6	PU	Pb-Zn ore (Quintania mine)		○	○						○	
367	OP018	6	PU	Pb-Zn ore (Quintania mine)		○	○							
368	KP019	4	TV	Volcanic conglomerate	○									

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Radioactivity
369	OP030	1	PU	Dolomitic limestone				○					○	
370	OP033	11	PU	Crystalline dolomite	○								○	
371	HP034	11	PU	Grey dolomite	○								○	
372	HP038	18	PU	Dark grey limestone	○								○	
373	HP039	18	PU	Grey dolomite	○								○	
374	HP042	15	PU	Black limestone	○			○					○	
375	HP043	9	PU	Crystalline dolomite	○								○	
376	HP044	9	PU	Grey dolomite	○			○					○	
377	HP047	9	PU	Grey dolomite	○			○					○	
378	FP047A	11	PU	Black shale							○			
379	FP047B	11	PU	" "							○			
380	HP050	11	PU	Crystalline dolomite	○			○					○	
381	OP050	15	PU	Pyrite dissemination		○	○							○
382	OP051	15	PU	Sphalerite ore			○							
383	OP052	15	PU	" "		○	○						○	
384	OP053	15	PU	" "		○	○						○	
385	OP054	15	PU	" "		○	○						○	
386	OP055	15	PU	" "		○	○						○	○
387	OP056	15	PU	" "		○	○						○	○
388	OP057	15	PU	" "		○	○						○	○
389	OP058	15	PU	" "		○	○						○	○
390	HP059	15	PU	Fine grey dolomite	○			○					○	
391	HP061	15	CR	Red sandstone	○									
392	OP063	15	PU	Sphalerite bearing vein			○							
393	OP064	15	PU	" "		○	○						○	
394	OP065	15	PU	" "			○							
395	HP071	18	PU	Light grey limestone	○			○					○	
396	OP072	18	PU	Cu-oxide bearing limestone		○	○	○					○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
397	GP073	16	PU	Pb ore (float)		O								
398	RP075	11	PU	Sandy shale	O									
399	LP001	4	PU	Grey limestone									O	
400	LP002	4	PU	Dark grey limestone									O	
401	LP010	4	PU	Dark grey limestone				O					O	O
402	LP012	4	PU	Light grey dolomite				O					O	
403	LP017	4	PU	Dark grey limestone				O					O	O
404	LP025	7	PU	Black limestone									O	
405	LP040	6	PU	Crystalline dolomite				O					O	
406	LP051	6	PU	Crystalline dolomite				O					O	
407	LP087	7	PU	Black limestone				O					O	O
408	LP090	7	PU	Black limestone				O					O	O
409	LP096	9	PU	Crystalline dolomite				O					O	
410	LP098	9	PU	" "				O					O	
411	LP109	9	PU	" "				O					O	
412	LP110	9	PU	Zebra dolomite				O					O	
413	LP112	9	PU	" "				O					O	O
414	LP124	1	PU	Crystalline dolomite									O	
415	LP158	10	PU	Tuffaceous shale									O	
416	LP160	10	PU	Grey limestone				O					O	
417	LP172	11	PU	Crystalline dolomite				O					O	
418	LP174	11	PU	Crystalline dolomite				O					O	O
419	LP175	11	PU	Grey limestone									O	
420	LP176	11	PU	" "									O	
421	LP200	18	PU	Dark grey limestone				O					O	
422	LP201	18	PU	Zebra dolomite				O					O	
423	LP202	18	PU	Grey dolomitic limestone				O					O	
424	LP265	14	PU	Crystalline dolomite				O					O	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
425	LF279	11	FU	Black limestone				○					○	○
426	LF305	14	FU	Dark grey limestone									○	
427	LF307	9	FU	Crystalline dolomite				○					○	
428	LF309	9	FU	" "				○					○	
429	LF318	9	FU	" "				○					○	
430	LF325	11	FU	" "									○	
431	LF327	14	FU	Dark grey limestone				○					○	
432	LF332	14	FU	Grey limestone									○	
433	LF335	14	FU	Black limestone				○					○	○
434	LF340	15	FU	Crystalline dolomite									○	
435	LF342	15	FU	Brecciated dolomite				○					○	
436	LF376	15	FU	Zebra dolomite				○					○	
437	LF377	15	FU	Fine brecciated dolomite									○	
438	LF378	15	FU	" "									○	
439	LF379	15	FU	Fine grey dolomite									○	
440	LF380	15	FU	" "				○					○	
441	LF381	15	FU	Zebra dolomite				○					○	
442	LF382	15	FU	Fine grey dolomite				○					○	
443	LF388	16	FU	Crystalline dolomite									○	
444	LF390	16	FU	Crystalline dolomite				○					○	○
445	LF392	16	FU	Crystalline dolomite									○	
446	LF393	16	FU	Dark grey limestone				○					○	○
447	LF395	16	FU	Crystalline dolomite				○					○	
448	LF396	16	FU	Light grey dolomite				○					○	
449	LF435	18	FU	Grey dolomite				○					○	
450	LF436	18	FU	Light grey limestone				○					○	
451	F0003A	4	FU	Black limestone							○			
452	F0003B	4	FU	" "							○			

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
453	HG005	4	PU	Dolomitic limestone	O								O	
454	HG009	4	MP	Acidic tuff	O									
455	HG011	4	PU	Light grey dolomite	O			O					O	
456	HG021	6	PU	Siliceous dolomite	O			O					O	
457	OG027	7	PU	Zn-Pb ore		O	O						O	
458	HG042	1	PU	Siliceous dolomite	O			O					O	
459	HG072	12	PU	Black limestone	O								O	O
460	HG073	12	OR	Arkose sandstone	O									
461	OG079	18	MD	Zn ore		O	O							
462	HG087	13	CG	Granite	O									
463	HG089	13	PU	Silicified limestone	O								O	
464	HG091	13	PU	Silicified limestone	O								O	
465	HG105	14	PU	Black limestone	O								O	
466	HG106	14	PU	Siliceous rock	O								O	
467	HG111	14	PU	Dark grey limestone	O								O	
468	OG116	16	PU	Dolomite (Zebra)		O	O	O					O	
469	HG118	16	PU	Green tuff	O									
470	HG120	19	PU	Siliceous dolomite	O			O					O	
471	OG123	19	MD	Gossan			O							
472	LG119	9	PU	Light brownish dolomite				O					O	O
473	LG124	9	PU	Dolomite (Zebra)				O					O	
474	LG136	9	PU	Dolomite				O					O	O
475	LG151	9	PU	Dolomite				O					O	O
476	LG166	1	PU	Dolomite									O	
477	LG177	1	PU	Light grey dolomite				O					O	
478	LG186	9	PU	Dark grey limestone									O	
479	LG200	11	PU	Dolomite				O					O	
480	LG249	10	PU	Black limestone									O	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
481	LG251	10	FU	Dolomite				○					○	
482	LG259	11	FU	Dolomite				○					○	○
483	LG266	10	FU	Dolomite				○					○	○
484	LG278	13	FU	Black limestone				○					○	
485	LG284	11	FU	Dolomite									○	
486	LG286	11	FU	Dolomite (Zebra)				○					○	○
487	LG293	10	FU	Dolomite				○					○	○
488	LG326	11	FU	Breccia dolomite				○					○	○
489	LG330	9	FU	Dolomite				○					○	
490	LG341	14	FU	Black limestone				○					○	
491	LG360	16	FU	Dolomite				○					○	
492	LG363	16	FU	Dolomite				○					○	○
493	LG366	16	FU	Dolomite				○					○	
494	LG460	18	FU	Dolomite									○	
495	LG461	19	FU	Dolomite (Zebra)				○					○	
496	RH001	7	FU	Dolomite	○								○	
497	RH002	7	FU	Light grey limestone	○								○	
498	RH019	8	MP	Quartz porphyry	○									
499	OH020	8	FU	Pb ore (float)			○							
500	RH028	8	OR	Sandstone (float)	○									
501	RH030A	10	CG	Granite	○									
502	RH030B	10	CG	Granite	○									
503	OH038	12	FU	Cu ore	○		○							
504	OH039	12	FU	Fe-Pb ore		○	○						○	
505	RH040	12	TM	Porphyrite	○									
506	RH050	18	MI	Red sandstone	○									
507	RH051	15	CE	Red sandstone (calcareous)	○									
508	LH006	7	FU	Dolomite									○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Reactivity
509	LM011	7	PU	Dolomitic limestone									○	
510	LM018	4	PU	Dolomite (Zebra)				○					○	○
511	LM051	6	PU	Dolomite				○					○	
512	LM077	7	PU	Crystalline dolomite				○					○	
513	LM081	7	PU	Stalactite				○					○	
514	LM100	9	PU	Dolomite									○	
515	LM103	9	PU	Dolomite				○					○	
516	LM125	6	PU	Limestone									○	
517	LM126	6	PU	Dolomite									○	
518	LM130	6	PU	Limestone									○	
519	LM152	8	PU	Siliceous limestone				○					○	○
520	LM154	8	PU	Dolomitic limestone				○					○	○
521	LM160	8	PU	Limestone				○					○	○
522	LM163	8	PU	Limestone									○	
523	LM169	8	PU	Limestone				○					○	○
524	LM171	9	PU	Dolomite (Zebra)				○					○	○
525	LM179	9	PU	Dolomitic limestone				○					○	○
526	LM187	9	PU	Limestone				○					○	○
527	LM189	2	PU	Dolomite				○					○	
528	LM196	2	CK	Limestone				○					○	
529	LM211	2	PU	Dolomite									○	
530	LM214	2	PU	Crystalline dolomite				○					○	
531	LM223	2	PU	Limestone									○	
532	LM260	11	PU	Limestone				○					○	
533	LM261	11	PU	Dolomite				○					○	○
534	LM299	11	PU	Limestone				○					○	
535	LM300	11	PU	Dolomite									○	
536	LM301	11	PU	Limestone									○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
537	LM303	11	PU	Limestone									○	
538	LM310	11	PU	Dolomitic limestone				○					○	○
539	LM325	11	PU	Limestone				○					○	○
540	LM326	11	PU	Limestone									○	
541	LM328	11	PU	Dolomite									○	
542	LM329	11	PU	Crystalline dolomite				○					○	
543	LM332	11	PU	Breccia dolomite				○					○	○
544	LM333	11	PU	Dolomite									○	
545	LM335	11	PU	Dolomite				○					○	○
546	LM336A	11	PU	Dolomite (Zebra)				○					○	○
547	LM338A	11	PU	Siliceous limestone				○					○	○
548	LM340	11	PU	Dolomite				○					○	
549	LM344	11	PU	Sandy limestone				○					○	○
550	LM346A	12	PU	Limestone									○	
551	LM346B	12	PU	Dolomite									○	
552	LM355	12	PU	Dolomite									○	
553	LM359	15	PU	Limestone									○	
554	LM367	15	PU	Limestone									○	
555	LM369	15	PU	Limestone									○	
556	LM373	15	PU	Limestone									○	
557	LM380	14	PU	Siliceous limestone				○					○	○
558	LM387	14	PU	Dolomite				○					○	
559	LM388	14	PU	Dolomite									○	
560	LM389	14	PU	Crystalline dolomite				○					○	○
561	LM393	14	PU	Limestone									○	
562	LM396	14	PU	Limestone				○					○	○
563	LM399	14	PU	Limestone									○	
564	LM402	14	PU	Limestone									○	

(14)

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
565	LH404	16	FU	Black limestone				○					○	○
566	LH409	16	FU	Limestone									○	
567	LH422	16	CH	Dolomitic limestone				○					○	○
568	HI005	4	OR	Arkose sandstone	○									
569	HI012	5	FU	Grey sandstone	○									
570	HI033	7	FU	Dolomitic limestone	○			○					○	
571	HI043	7	FU	Grey dolomite	○								○	○
572	HI044	7	FU	Dolomite (Zebra)	○								○	○
573	HI048	7	FU	Black limestone	○								○	○
574	HI049	9	FU	Breccia dolomite				○					○	
575	HI058	1	FU	Black limestone				○					○	
576	HI060B	1	FU	Dolomitic limestone	○			○					○	
577	HI065	1	CH	Dolomitic limestone				○					○	
578	HI066B	1	CH	Purplish shale	○									
579	GI082	19	MD	Cu-Zn ore		○	○							
580	HI086	19	MD	Diorite	○									
581	HI089	11	FU	Black limestone							○			
582	HI091	11	FU	Black limestone									○	○
583	HI096	15	FU	Black limestone									○	○
584	HI100	11	FU	Light grey dolomite									○	○
585	HI102	15	CH	Siliceous sandstone	○									
586	HI103	15	CH	Porphyrite	○									
587	HI109	15	FU	Dolomite (Zebra)									○	
588	HI122	15	FU	Black limestone	○								○	○
589	HI131	16	FU	Dolomite (Zebra)				○					○	
590	HI133	16	FU	Grey limestone	○								○	
591	HI134	16	CH	Light grey dolomite	○			○					○	
592	HI141	19	FU	Brecciated limestone	○								○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
593	LI001	4	PU	Limestone				○					○	
594	LI002	4	PU	Limestone				○					○	
595	LI005	9	PU	Limestone									○	
596	LI006	1	PU	Dolomite									○	
597	LI007	1	PU	Limestone									○	
598	LI008	1	PU	Limestone									○	
599	LI009	9	PU	Dolomite									○	
600	LI011	10	PU	Dolomite				○					○	
601	LI012	10	PU	Dolomite				○					○	
602	LI013	10	PU	Breccia dolomite				○					○	○
603	LI014	10	PU	Limestone									○	
604	LI015	19	PU	Limestone				○					○	
605	LI016	10	PU	Limestone									○	
606	LI017	10	PU	Grey limestone				○					○	○
607	LI018	13	PU	Grey limestone				○					○	○
608	LI019	13	PU	Dolomite				○					○	
609	LI021	15	PU	Limestone				○					○	○
610	LI022	15	PU	Black limestone				○					○	○
611	LI023	15	PU	Limestone				○					○	
612	LI024	14	PU	Dolomite				○					○	
613	LI025	15	PU	Limestone				○					○	
614	LI026	15	PU	Dolomite				○					○	
615	LI027	11	PU	Limestone									○	
616	LI028	16	PU	Grey limestone				○					○	○
617	LI029	16	PU	Dolomite				○					○	
618	PCP001	16	PU	Black limestone							○			
619	LCP011	16	PU	Limestone									○	
620	LCP016	16	PU	Limestone									○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
621	LCP022	16	PU	Limestone									○	
622	LCP024	16	PU	Limestone									○	
623	PCP043	15	PU	Limestone							○			
624	ZKB 1	9	PU	Dolomite (zebra)									○	
625	ZKB 2	9	PU	Dolomite (zebra)									○	
626	ZKB 3	9	PU	Crystalline dolomite									○	
627	ZKB 4	9	PU	Dolomite (zebra)									○	
628	ZKB 5	9	PU	Dolomite (zebra)									○	
629	ZKB 6	9	PU	Dolomite (zebra)									○	
630	ZKB 7	9	PU	Breccia dolomite									○	
631	ZKB 8	9	PU	Dolomite (zebra)									○	
632	ZKB 9	9	PU	Breccia dolomite									○	
633	ZKB 10	9	PU	Dolomite									○	
634	ZKB 11	9	PU	Dolomite									○	
635	ZKB 12	9	PU	Dolomite (zebra)									○	
636	ZKB 13	9	PU	Dolomite									○	
637	ZKB 14	9	PU	Dolomite (zebra)									○	
638	ZKB 15	9	PU	Dolomite (zebra)									○	
639	ZKB 16	9	PU	Dolomite (zebra)									○	
640	ZKB117	9	PU	Dolomite									○	
641	ZKB 18	9	PU	Dark grey limestone									○	
642	HA065	1	PU	Dolomitic limestone									○	
643	HK001	9	PU	Dolomite (zebra)									○	
644	HK002	9	PU	Dolomite (zebra)									○	
645	HK003	9	PU	Dolomite (zebra)									○	
646	HK004	9	PU	Dolomite (zebra)									○	
647	HK005	9	PU	Dolomitic limestone									○	
648	HK006	9	PU	Dolomite (zebra)									○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
649	HK007	9	FU	Dolomitic limestone									○	
650	HK008	9	FU	Dolomitic limestone									○	
651	HK009	9	FU	Limestone									○	
652	HK010	9	FU	Limestone									○	
653	HK011	9	FU	Dolomitic limestone									○	
654	HK012	9	FU	Limestone									○	
655	HK013	9	FU	Limestone									○	
656	HK014	9	FU	Limestone									○	
657	HK015	9	FU	Limestone									○	
658	HK016	9	FU	Limestone									○	
659	HK017	9	FU	Limestone									○	
660	HK018	9	FU	Limestone									○	
661	HK019	9	FU	Limestone									○	
662	HK020	9	FU	Limestone									○	
663	HK021	9	FU	Limestone									○	
664	HK022	9	FU	Dolomitic limestone									○	
665	HK023	9	FU	Limestone									○	
666	HK024	9	FU	Dolomitic limestone									○	
667	HK025	9	FU	Dolomitic limestone									○	
668	HK026	9	FU	Limestone									○	
669	HK068	19	FU	Dolomite (zebra)									○	
670	HK069	19	FU	Dolomite (zebra)									○	
671	HK129	9	FU	Dolomite (zebra)									○	
672	HK130	9	FU	Dolomite									○	
673	HK131	9	FU	Limestone									○	
674	HK132	9	FU	Dolomite									○	
675	HK138	9	FU	Dolomite (zebra)									○	
676	HK139	9	FU	Dolomite (zebra)									○	

Sample No.	Field No.	Location	Geological unit	Rock name	Thin section	Polished section	Chemical analysis (ore)	X-ray	Dating	Chemical analysis (whole rock)	Fossil	Pollen	Minor element	Resistivity
677	MS223	11	FU	Dolomitic limestone									O	
678	MS272	7	FU	Dolomite (zebra)									O	
679	MS015	15	Ot	Dolomite									O	
680	MS023	15	FU	Dolomite (zebra)									O	
681	MS024A	15	FU	Dolomite (zebra)									O	
682	MN036	18	FU	Dolomite (zebra)									O	
683	MN037A	18	FU	Dolomite (zebra)									O	
684	MN037B	18	FU	Dolomitic limestone									O	
685	MN035	18	FU	Grey limestone									O	

Table 6. Microscopic Observation of the Thin Section

(1)

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
214	S003	18B	OR	Sandstone	The rock shows medium grained, well-sorted and mainly composed of quartz, cherty rock fragments and feldspares with accessory sericite. The grains are subrounded in shape. Small biotite grains (less than 0.2mm in diameter) also are contained.
215	S004	18B	CH	Limestone	The rock shows microcrystalline (" micritic") texture and contains several percent of quartz and feldspar, being less than 0.2mm in size and subrounded to subangular in shape. Some foraminiferas are recognized in the section.
216	S006	18B	CH	Shale	Subangular to subrounded small grains (less than 0.05mm in diameter) of quartz, potash feldspar, sericite and opaque minerals are cemented by carbonate mineral (probably, calcite). The rock is well sorted.
217	S008	18B	CH	Shale	The rock is composed of quartz, potash feldspar, plagioclase, sericite and argillaceous matters. The grains are somewhat coarser than S006 specimen, and are angular to subrounded in shape. Cement is calcite. Calcite vein (about 0.1mm in width) is observed.
219	S013	18B	PU	Dolomite	The rock shows coarse (up to 1.00mm in maximum diameter) crystalline (sparitic) texture and is composed of mosaic of carbonate(dolomite) anhedral. Other minerals such as opaque minerals also are contained very rarely.
220	S014	18B	PU	Dolomite	The rock is the same as S013 composed of mosaic of dolomite anhedral, and shows sparitic texture.
221	S015	18B	PU	Limestone	The rock shows micritic texture and contains a few percent of small (less than 0.02mm in size) quartz and feldspar. Some feldspar grains are replaced by carbonate minerals (calcite).
222	S017	18B	CH	Limestone	The rock is the same as S015 specimen. Some fissures (less than 0.4 mm in width) are filled up with spary calcite.
223	S019	19B	HU	Sandstone	The rock shows medium to coarse grained and moderately sorted. Subangular to subrounded grains of quartz, potash feldspar, plagioclase and opaque minerals are well cemented by carbonate mineral (probably calcite). The grains composed of mosaic quartz and sericite also contained slightly.
224	S022	20B	HU	Sandstone	The rock shows very coarse to coarse grained and moderately sorted. The grains are subangular to subrounded in shape and well cemented with cabonate mineral (calcite). Main component is quartz, potash feldspar and plagioclase. Opaque minerals and sericite also occur as accessory minerals.
225	S027	12E	CH	Sandstone	The rock shows fine grained and moderately sorted, and contains up to 30 percent of argillaceous matrix. Angular to subrounded grains of quartz, feldspars and opaque minerals are cemented with carbonate mineral (calcite).

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
226	S030A	12E	TM	Altered dolerite	Strongly altered rock. Although the relics of medium grained subophitic texture are observable in some parts, original menerals are completely altered to the aggregates of cryptocrystalline low index material (probably of feldspathic composition), calcite and/or dolomite. Opaque minerals, such as ilmenite, hematite and limonite are abundant. Some aggregates surrounded by polygonal framework of opaque minerals seem to be relic of mafic minerals. Constituent minerals are cryptocrystalline feldspathic mineral, relic plagioclase, calcite, ilmenite, hematite, limonite.
227	S030B	12E	TM	Altered doleritic breccia	Strongly altered red colored breccia and matrix. The breccia may originally be fine-grained dolerite, suggested from the relic ophitic texture, but the constituent minerals are completely altered to irregular calcite patches, clay minerals, and minor amount of reddish brown, strongly pleochroic phyllosilicate mineral, probably pseudomorph of olivine. Vein-like red colored matrix is composed of angular quartz and feldspar grains of silt size, pseudomorph of mafic minerals, calcite patches, and opaque minerals. Calcite also occurs as thin veinlets. Constituent minerals are calcite, clay minerals, quartz, feldspar, pseudomorph of olivine (?) (reddish brown phyllosilicate mineral) and other mafic minerals, opaque minerals.
228	S031	9F	BC	Garnet muscovite biotite gneiss	Medium grained gneissose texture. Major constituent minerals are quartz, alkali feldspars (mostly microcline) biotite and muscovite. Minor constituent minerals are grossular garnet, epidote, sphene, magnetite and hematite. Quartz and alkali feldspar(mostly microcline) grains show undulatory extinction. Rounded quartz grains are sometimes included in microcline. Grossular garnets are small, rounded and colorless crystals with slight anisotropism. Irregularly oriented deep olive-green small biotite flakes line up to form gneissosity.
229	B001	7G	TM	Soda-augite hornblende monzonaite porphyry	This rock shows fine grained, weakly porphyritic texture. Main constituent minerals are plagioclase, alkali feldspar, hornblende, soda-augite and biotite. Porphyritic larger crystals in this rock are mainly plagioclase. It shows weakly zoning, and is altered to epidote and sericite. Alkali feldspar exists interstitially among other minerals. Hornblende shows distinct pleochroism and remarkable zoning, and its marginal part is weakly riebeckitic in composition. Soda-augite is partly replaced by hornblende, and its pleochroism is not so weak. Biotite occurs in hornblende crystals. Minor constituents are sphene, apatite and ore mineral. As secondary minerals, sericite and considerable amounts of epidote are present.
230	B002	20D	HU	Sandstone	The rock is medium to fine grained and moderately sorted. The rock is mainly composed of quartz, potash feldspar and plagioclase with accessory opaque minerals and sericite. Grains are angular to subrounded in shape and cemented with carbonate mineral (calcite). Argillaceous matters are contained up to 20 percent. Feldspares are altered partly to sericite and replaced by calcite.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
232	B004	20D	VI	Sandstone	The rock shows medium grained and well sorted. The rock is not altered and contains less than several percent of argillaceous matrix (pure sandstone——arenite type). Subangular to subrounded grains are composed of quartz, potash feldspar and plagioclase.
233	B005	20D	CH	Sandstone	The rock shows cross lamination, fine to very fine grained, and moderately sorted. Angular to subangular grains of quartz, potash feldspar and plagioclase are cemented with carbonate mineral (calcite). Opaque minerals are partly arranged along lamina.
234	B008	20D	OR	Sandstone	The rock shows medium grained and well sorted. Grains are subangular in shape and composed mostly of quartz. A few feldspar and sericite also are contained. The rock is arenite type sandstone as B004 specimen.
235	B009	20D	SA	Sandstone	The rock is poorly sorted and composed of quartz, potash feldspar, plagioclase, sericite,and opaque minerals. Feldspars altered to sericite. Argillaceous matters are contained up to 30 percent. Grains are subangular to subrounded in shape.
236	B012	19C	CH	Limestone	The rock shows micritic texture and contains rarely subangular to subrounded small (less than 0.1mm in diameter)grains of quartz.
238	B014	16B	PU	Dolomite	The rock shows sparitic texture and is composed of mosaic of dolomite anhedral. Very small (less than 0.05mm in maximum diameter) grains of opaque minerals also occur very rarely.
239	B015	15C	PU	Sandstone	The rock is very fine grained and poorly sorted, and composed of quartz, potash feldspar,and plagioclase. Iron minerals and opaque minerals observed in matrix. Calcite filled up some fissures.
240	B018	14C	MD	Metadolerite	Cataclastic medium grained biotite bearing metadolerite of ophitic texture. Major constituent minerals are plagioclase (labradorite), uralite, brown hornblende and biotite. Minor constituent minerals are actinolite, chlorite, prehnite, epidote, calcite, apatite, sphene, ilmenite, magnetite, leucoxene and hematite. Plagioclase crystals are euhedral and often show monotonous normal zoning from labradorite core to oligoclase rim. Some augites are uralitized or completely altered to brown hornblende, but the others are fresh and rarely show sector zoning. Biotite is often associated with hornblende and commonly replaced by chlorite. These minerals are crushed to fragments along several fractures.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
242	B019	14C	MI	Altered porphyritic andesite	Phenocryst consists of plagioclase (andesine), sanidine and pseudomorph of mafic mineral. Groundmass consists of plagioclase, analcite, epidote, sericite, apatite, sphene, ilmenite, magnetite, leucoxene and hematite. Plagioclase and sanidine occur as euhedral or subhedral phenocryst of 1/2 to 2mm in diameter. Plagioclase phenocrysts are andesine composition and not zoned. Groundmass is filled with microlites of sodic plagioclase in felty texture. Small euhedral crystals of analcite, sphene and epidote are disseminated in the groundmass. The aggregate composed of sericite, epidote and hematite in a magnetite framework occur as corroded subhedral pseudomorph of mafic mineral.
242	B020	14C	MI	Keratophyre	Aphyric felty texture. Major constituent mineral is sodic plagioclase. Minor constituent minerals are quartz, biotite, muscovite, apatite, limonite, hematite, sericite. Groundmass is composed of sodic plagioclase and quartz microlites with small amounts of minute sericite and leucoxene. Local difference in crystallinity, even cryptocrystalline in some parts, causes spotted appearence. Quartz and small micas form veinlets and patches everywhere. Many irregular limonite veins are probably generated by weathering.
243	B021	14C	MD	Altered andesite	Fine grained porphyritic texture. Phenocryst consists of quartz and alkali feldspars. Groundmass consists of quartz, alkali feldspars, sericite, sphene, silimanite(?), magnetite and other opaque minerals. Quartz and alkali feldspars occur as phenocryst. Quartz is subhedral to anhedral corroded crystal of 0.4mm in diameter. Alkali feldspars are hardly altered to the aggregate of sericite, sometimes rimmed by opaque minerals. Groundmass shows felty texture and filled with microlites of quartz, alkali-feldspar, sericite and opaque minerals. Trace amounts of silimanite(?) occur.
244	B022	14B	MD	Metadolerite	Medium grained subophitic texture. Major constituent minerals are plagioclase (labradorite), and augite. Minor constituent minerals are actinolite, epidote, pumpellyite, chlorite, ilmenite and leucoxene. Plagioclase is relatively fresh and shows weak normal compositional zoning. Augite is partly altered to very pale green amphibole with slight pleochroism, probably of actinolitic composition. Secondary pumpellyite shows characteristic blue-green color. Ilmenites of needle-like or hexagonal form are abundant, and some of them are altered to leucoxene.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
245	B023	14B	BC	Biotite-muscovite gneiss	Coarse grained granoblastic texture. Major constituent minerals are quartz, potash feldspar and muscovite. Minor constituent minerals are biotite, chlorite, apatite, zircon, sphene, opaque minerals and silimanite(?). Some quartz grains measure up to 10mm. Quartz grains show strong cataclastic features as cracks, marginal granulation and undulatory extinction. Potash feldspar is mostly altered to sericite. Sodic plagioclase is not detected. Biotite is partly altered to chlorite. Cleavages of muscovite are sometimes filled with opaque mineral (hematite?). Trace amount of silimanite(?) occurs.
246	B024	14B	MD	Porphyrite	Fine grained intersertal texture. Phenocryst is plagioclase (andesine). Groundmass consists of plagioclase (andsine), green hornblende, quartz, biotite, epidote, chlorite and opaque minerals (ilmenite, magnetite, etc.). Plagioclase(andsine?) partly altered to sericite and chlorite rarely occurs as phenocryst of 1mm in diameter. Major portion of the rock is homogeneous intersertal groundmass composed of subhedral to euhedral plagioclase, anhedral green hornblende, interstitial quartz, minor biotite and opaque minerals (probably ilmenite is dominant).
247	B025	14B	MI	Conglomerate	The rock is poorly sorted and composed mainly of plagioclase, potash feldspar, and quartz with small amount of sericite and opaque minerals. Grains are subrounded to subangular in shape. Quartz vein also is observed. Feldspars are altered partly to sericite.
248	B026	15C	MI	Porphyritic keratophyre	Phenocryst is albite. Groundmass is composed of albite, chalcedony(?), epidote, chlorite, sphene, leucoxene and opaque minerals. Fresh euhedral albite phenocrysts of 1-3mm in diameter are scattered in spherulitic groundmass. Various kinds of twin are developed in albite phenocrysts. Spherules composed of radial aggregate of munite fibrous felsic mineral (chalcedony ?), about 1/2mm in diameter, are widespread in groundmass. The other part of groundmass shows felsitic texture and is stained by minute chlorite and leucoxene. Small patches of chlorite associated with opaque minerals are common.
249	B028-1	16B	PU	Dolomite	The rock shows mosaic texture and is composed mostly of dolomite anhedral. Small (less than 0.1mm in size) euhedral crystals of dolomite also are recognized rarely.
250	B028-2	14C	PU	Dolomite	As well as B028-1, the rock is composed of mosaic of dolomite anhedral. But this rock is somewhat different from B028-1 as regards crystal size. Dolomite crystals in this rock are poorly sorted and up to 3mm in the maximum diameter. The rock contains a little terrigenous grain (less than 0.05mm in size) of quartz in pore.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
251	B029	14D	VI	Sandstone	The rock shows medium to coarse grained and well sorted. This rock contains little argillaceous matrix and is composed mainly of quartz. Accessory minerals are zircon and sericite. Grains are angular to subangular in shape.
253	C002	20D	OR	Sandstone	The rock shows medium to fine grained and moderately sorted. The rock contains 10 percent or more argillaceous material and is composed mainly quartz and feldspars. Grains are subrounded to subangular in shape. Sericite also occurs as secondary minerals.
254	C004	19C	TM	Altered porphyritic andesite	Altered porphyritic intersertal texture. Phenocrysts are composed of plagioclase, sanidine, and hornblende pseudomorph. Groundmass is composed of plagioclase, quartz, calcite, opaque minerals, apatite, epidote and chlorite. Mafic mineral (hornblende ?) now completely altered to calcite-epidote-chlorite-quartz aggrigate, relatively fresh plagioclase and sanidine occur as phenocryst. Plagioclase crystals generally show strong normal compositional zoning from andesine core to more sodic rim. Groundmass is filled with microlites of plagioclase, quartz, calcite, and opaque minerals.
255	C006	19C	CH	Limestone	The rock is composed mainly of microcrystalline (micritic) carbonate mineral (calcite), and contains a little small (0.1mm or less in grain size) quartz, plagioclase, and opaque minerals. Long dimensions of most detrital grains lie roughly parallel to bedding (?).
256	C007	19C	VI	Sandstone	The rock shows fine grained and well sorted. Subrounded to subangular grains of quartz, plagioclase, potash feldspar, opaque minerals and sericite are cemented with carbonate mineral (calcite). Some fissures are filled up with calcite. About 10 or more percent of argillaceous material is contained.
257	C010	19C	TM	Porphyritic biotite keratophyre	Porphyritic texture. Phenocrysts are composed of albite, biotite, pseudomorph of mafic minerals (calcite, chlorite, and iron ore). Groundmass is composed of albite, apatite, calcite, micas, sphene, limonite and other opaque minerals. Subhedral albite, biotite, and pseudomorph of mafic mineral occur as phenocryats up to 3mm in diameter. Pseudomorph of mafic mineral is composed of calcite, chlorite and iron ore. Euhedral apatite up to 1/2mm, indeterminable minute opaque minerals, calcite and micas are disseminated among microlites of albite, the main constituent of pilotaxitic groundmass. Calcite occur also as thin veinlets. Quartz is absent.
258	C011	19C	HU	Sandstone	The rock is poorly sorted and composed quartz, cherty rock fragments and feldspars. Sericite of the secondary origin and opaque minerals are contained. Grains are angular to subrounded in shape.
259	C013A	16A	PU	Dolomite	The rock shows sparitic texture and is composed of mosaic of dolomite anhedral. Fissure (0.1mm or less in width) also is filled up with carbonate mineral.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
260	C014	17B	PU	Dolomite	As well as C013 specimen, the rock shows sparitic texture, and is composed of mosaic of dolomite anhedral. Small (less than 0.1mm in size) opaque minerals occur.
261	C015	10D	PG	Biotite granodiorite	Medium grained subhedral granular texture. Major constituent minerals are quartz, oligoclase and biotite. Minor constituent minerals are microcline, chlorite, epidote, sphene, apatite and magnetite. Grain size is variable as to cause porphyritic appearance. Quartz Crystals occur rather interstitial to feldspars and show moderate cataclastic features as cracks and undulatory extinction. Oligoclase is far abundant than microcline, and shows weak compositional zoning. Biotite is partly altered to chlorite and epidote.
262	C017	17B	CH	Limestone	The rock shows micritic texture. A little terrigenous grains of quartz and feldspars are contained. One large (up to 1mm in maximum diameter) grain of altered plagioclase is recognized in this specimen.
263	C020	14C	PU	Sandstone	The rock is very fine grained. Subangular to subrounded grains of quartz and plagioclase are well cemented with carbonate mineral (calcite). Most grains are altered to be identified, too.
264	C021	13C	PU	Dolomite	The rock shows sparitic and mosaic texture, and is composed of anhedral dolomite crystals. Other minerals such as quartz are recognized rarely.
265	C022	13C	MI	Dacitic lapilli tuff	Major constituent minerals are alkali feldspars, quartz and clay minerals. Minor constituent minerals are calcite, zircon and opaque mineral. Crystal ejecta are richer than lithic ejecta. Alkali feldspars are generally angular fragments, but quartz is rather rounded. Two types of lithic ejecta present; the one is the fragments of dark colored glass with plagioclase microlites, and the other is the aggregate of plagioclase microlites. Calcite fills up vesicles or scattered among silty matrix as well as opaque minerals. Minute zircon is detected.
266	C023	13D	MI	Shale	The rock shows laminated texture and contains large (8mm in the maximum diameter) sandstone rock fragment and subangular to subrounded grains (0.5mm or less in size) of plagioclase and potash feldspar. The rock is wholly composed of fine grained quartz mosaic.
267	C024	10D	PG	Porphyrite	Fine grained intergranular texture. Plagioclase is partly altered to epidote, prehnite, chlorite and clay minerals. Augite is strongly uralitized. Two species of amphibole present. Colorless hornblende (tremolite ?) generally encloses brown hornblende. Small amounts of primary quartz also present. Major constituent minerals are plagioclase (altered), brown-hornblende, tremolite and augite. Minor constituent minerals are epidote, quartz, sphene, clay minerals, leucoxene, hematite and pyrite.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
268	C025	12D	PG	Biotite-bearing quartz diorite	This rock shows hypidiomorphic, equigranular texture, and is coarse grained. Main constituent minerals are quartz and plagioclase. Quartz shows remarkable undulatory extinction; dust inclusions are common. Plagioclase is moderately sericitized, and shows commonly lamellar twinning, partly sericitized, sometimes mantled by thick sodic rim. Minor constituent minerals are biotite, sphene and potash-feldspar. Biotite is completely altered to chlorite. Potash-feldspar is interstitially present with sphene. As secondary epidote and sericite are present. The former mineral occurs either in plagioclase, or along grain boundary, or rarely as vein.
269	C026	12D	MI	Dacitic coarse tuff	Major constituent mineral is alkali feldspars. Minor constituent minerals are calcite, chlorite, pumpellyite, apatite and opaque minerals. Visible grains are mostly poorly rounded crystalline ejecta of alkali feldspars or the aggregate of them. The rest of them are made of calcite, opaque minerals or chlorite. Alkali feldspars are partly altered to chlorite and calcite. Matrix is composed of microlites of alkali feldspars, calcite, chloritic clay minerals, minor pumpellyite and sphene. Small euhedral apatite is also detected.
270	C027	12D	MI	Andesitic lapilli tuff	Major constituent mineral is sodic plagioclase. Minor constituent menerals are epidote, iron ore, sphene, clay minerals, potash-feldspar (?) and zeolite (?). The rock is rich in essential lithic ejecta of several kinds; (1) holocrystalline aggregate of subhedral plagioclase, (2) pilotaxitic or hyalopilitic andesite lapilli with or without plagioclase phenocryst, (3) dark colored glass with minute plagioclase laths, (4) lapilli wholly made of volcanic glass. The matrix is composed of minute lithic or crystalline fragments, anhedral epidote, iron ore and clay minerals. The abundance of epidote is chracterristic. Zeolite also may be present.
271	C028	11D	PG	Biotite hornblende diorite	This rock shows hypidiomorphic fine grained, equigraular texture. Main constituent minerals are plagioclase, hornblende, biotite and small amount of quartz and potash-feldspar. Plagioclase is prismatic in shape and moderately sericitized, and shows moderately zoning. Hornblende is present as fibrous crystal of greenish color, sometimes "uralitic", and as single crystal of brown color. Biotite is mostly altered to chlorite, epidote and ore mineral (probably, ilmenite). A small amounts of quartz and potash - feldspar occur interstitially. Minor constituent minerals are ore minerals and apatite. Ore mineral is probably magnetite, and occurs in contact with hornblende. Apatite shows long prismatic to acicular in shape, and it occurs not rarely. As secondary minerals, sericite, chlorite, epidote and calcite are present.
272	C029	12D	MI	Andesitic coarse tuff	Major constituent mineral is plagioclase (andesine). Minor constituent minerals are quartz, sericite, epidote, chlorite, calcite, sphene, opaque minerals and clay minerals. The rock is rich in crystalline ejecta. Andesine crystals are dominant and quartz crystals are subordinate. Most of them are poorly rounded, moderately weathered fragments of about 1mm in diameter. Some quartz crystals show corroded form. Anhedral small epidote, calcite and sericite are disseminated among cryptocrystalline matrix. Epidote often forms small amygdaloidal aggregate. Chlorite patches, opaque minerals and sphene also occur.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
273	C030	12D	MI	Dacitic welded tuff	Major constituent mineral is sodic plagioclase. Minor constituent minerals are quartz, epidote, chlorite, calcite, sericite, apatite, zeolite and clay minerals. Both lithic and crystalline ejecta occur as their long axis parallel to lamination. Crystalline ejecta are composed of sodic plagioclase and quartz, the former is partly altered to epidote, sericite and zeolite. Lithic ejecta are fragments of dark colored glass with minute plagioclase laths. Matrix is microcrystalline and thin films of limonite form lamination. Calcite, epidote, chlorite, sericite and opaque minerals are disseminated in the matrix.
274	C031	12D	MI	Dacitic welded tuff	Major constituent mineral is palgioclase (andesine). Miner constituent minerals are epidote, chlorite, apatite and iron ore. Relatively fresh andesine, up to 2mm in diameter, occur abundantly as crystalline ejecta. Hyalopilitic andesite fragments of the same size occur as lithic ejecta. Cryptocrystalline matrix is scattered with epidote and thin films of iron ore to form lamination. Small chlorite patch also occur in the matrix.
275	C032	12D	MI	Dacitic coarse tuff	Major constituent minerals are quartz, sodic plagioclase and clay minerals. Minor constituent minerals are epidote, chlorite, calcite, apatite, sphene and hematite. Crystalline ejecta are richer than lithic ejecta. Crystalline ejecta are composed of quartz, alkali feldspars and mafic minerals now completely altered to epidote aggregate. Plagioclase is partly altered to chlorite, epidote and calcite. Pseudomorphs of biotite sometimes occur. Epidote, calcite and hematite are disseminated in clayey matrix.
276	C033	12D	MI	Sandstone	The rock shows very coarse to coarse grained and poorly sorted, and contains 10 percent or less argillaceous matrix. Grains are subangular to subrounded in shape and composed of quartz, potassium feldspar, plagioclase and opaque minerals. Feldspars are altered partly to sericite. This rock is cemented with carbonate mineral (calcite).
278	A001	19B	PU	Dolomite	The rock shows sparitic texture and is composed of mosaic of dolomite anhedral. Dolomite crystals are variable in size partially (from up to 1mm to less than 0.2mm).
279	A002	19B	PU	Dolomite	The rock shows sparitic and mosaic texture, and is composed of dolomite anhedral, as well as A001 specimen.
280	A005	19C	CK	Sandstone	The rock is medium to fine grained and well sorted. Main components are quartz, potash feldspar, plagioclase and calcite as cement. Sericite and opaque minerals also occur as accessory minerals. Grains are subrounded to subangular in shape.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
282	A008	13B	PC	Muscovite-biotite gneiss	Medium grained anhedral granoblastic texture. Major constituent minerals are quartz, alkali feldspars, biotite, muscovite and sericite. Minor constituent minerals are chlorite, zircon, leucoxene and hematite. Gneissosity is not distinct under microscope. Alkali feldspars are completely altered to sericite aggregate. Biotite is partly altered to chlorite. Quartz crystals are broken into fragments by many small cracks, and each fragment is the aggregate of interlocking minute quartz grains showing strong undulatory extinction.
283	A010	14B	MI	Conglomerate	The rock is very poorly sorted and composed of volcanic rock fragments, plagioclase, quartz and potash feldspar with accessory opaque minerals and sericite. Grains are angular to subrounded in shape. Feldspars are altered to sericite.
284	A011	14B	MI	Sandstone	The rock is medium to fine grained, well sorted, and composed of subangular to subrounded grains of quartz, potash feldspar, plagioclase, opaque minerals and sericite. Argillaceous matrix is about 10 percent in volume.
285	A013	14B	MI	Conglomerate	The rock shows very poorly sorted and is composed mainly of quartz grains and mosaic quartz grains. Potash feldspar also is contained, but it is altered partly to sericite and small size (less than 0.3mm in the maximum diameter). Iron minerals fill into matrix portion. Opaque minerals and secondary sericite occur as accessory minerals.
286	A014	14B	MI	Sandstone (?)	The rock shows very poorly sorted and is composed of irregular shaped (angular to subangular) grains. Grains are quartz, potash feldspar, plagioclase, opaque minerals and sericite. Feldspars are generally altered to sericite.
287	A016	14B	PC	Biotite hornblende diorite	This rock shows hypidiomorphic medium grained and equigranular texture. Main constituent minerals are plagioclase, hornblende, biotite, and ore mineral. Plagioclase shows commonly lamellar twinning, and is mostly altered to epidote, chlorite and sericite. Hornblende is mostly chloritized. Biotite mostly chloritized and opacitized. Ore mineral generally occurs in contact with mafic silicates. Minor constituent minerals are apatite and quartz. As secondary mineral, a large amounts of chlorite, epidote and sericite occurs.
288	A017	14B	PC	Garnet-biotite-muscovite gneiss	Medium grained lepidoblastic texture. Major constituent minerals are quartz, albite, potash feldspar, muscovite, and chlorite. Minor constituent minerals are garnet, biotite, epidote, zircon, sphene, calcite, apatite, ilmenite and hematite. Quartz grains show moderate undulatory extinction. Potassium feldspar grains are stained by numerous minute sericite flakes. Garnet and biotite are partly altered to chlorite.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
289	A018	14B	BC	Garnet-chlorite-muscovite schist	Fine grained lepidoblastic texture. Major constituent minerals are quartz, albite, muscovite and chlorite. Minor constituent minerals are garnet, apatite, sphene and opaque minerals. Garnet is colorless under open nichol, and some of them form porphyroblasts up to 1mm in diameter, though the average is about 0.4mm. Flakes of chlorite, muscovite and films of limonitic iron ore form distinct schistocty.
290	A019	13B	PG	Cataclastic metadiorite	Major constituent minerals are plagioclase (labradorite), brown hornblende, green hornblende and epidote. Minor constituent minerals are albite, chlorite, calcite, sphene, apatite, leucoxene and pyrite. All crystals are more or less deformed and set apart to fragments showing undulatory extinction. Plagioclase crystals are of labradoritic composition and their cracks are sometimes filled with albite. Brown and green hornblendes are often associated in complicated manner.
291	A020	13B	PG	Cataclastic muscovite-biotite granite	Medium grained cataclastic texture. Major constituent minerals are quartz, microcline, sodic plagioclase, biotite and muscovite. Minor constituent minerals are epidote, garnet (?), sphene and magnetite. Directional cataclasis causes gneissose appearance. Quartz "porphyroclasts" are broken into small granules, but feldspar grains are relatively less deformed. Cleavages of some biotite grains are strongly bended. Completely granulated fine grained matrix is composed of granoblastic aggregate of minute quartz, alkali feldspars and sericite. Small grains of sphene, epidote, magnetite and garnet (?) are scattered in the matrix.
292	A023	14C	PU	Limestone	The rock shows micritic texture and is composed of microcrystalline calcite mosaic. A little (less than several percent) opaque minerals and quartz (showing wavy extinction) also are contained.
294	A025	14C	PU	Limestone	The rock shows sparitic texture and is composed of mosaic of carbonate mineral. Small (less than 0.05 mm in size) quartz grains (subrounded in shape) also are contained.
295	A026	17E	CH	Limestone	The rock shows sparitic texture and is composed of mosaic of carbonate mineral anhedral. In this section, terrigenous grains of quartz and feldspars also are contained. Feldspars are altered partly to be replaced with carbonate mineral.
297	A028	17E	CH	Shale	The rock shows lamination and is composed of subangular to subrounded grains and altered feldspars. Opaque minerals and sericite occur as accessory minerals. The rock contains up to 20 percent of argillaceous materials and is cemented with carbonate mineral (calcite).
298	A029	17E	CH	Sandstone	The rock is medium grained, moderately sorted, and composed mainly of quartz, potash feldspar and plagioclase. Opaque minerals and sericite of secondary origin occur as accessory minerals. Grains are rounded to subangular in shape.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
299	A033	15D	VI	Sandstone	The rock is medium grained, moderately sorted, and contains little or no argillaceous matrix. The rock is contained of angular to subrounded grains of quartz, potash feldspar, plagioclase with accessory opaque minerals and sericite.
300	A034	15D	VI	Sandstone	As well as A033 section, the rock is composed of subrounded to subangular grains of quartz, potash feldspar and plagioclase. Opaque minerals and sericite also are recognized as accessory minerals. This rock shows fine grained and moderately sorted.
301	A037	19B	TM	Soda-augite hornblende monzonite	The texture of this section is hypidiomorphic medium grained, weakly porphyritic and protoclastic. Main constituent minerals are plagioclase, myrmekite, potash feldspar, quartz, hornblende, soda-augite and biotite. Minor constituent minerals are sphene, apatite, ore minerals and magnetite. Plagioclase is prismatic and partly sericitized, its zoning is moderate. Myrmekite is common along contacts between potash feldspar and plagioclase. Potash feldspar commonly shows perthite structure. Small granular crystals of quartz occur in small amount. Hornblende shows green to deep green color; in this mineral, inclusions of magnetite are common, augite not rarely occurs in core. Soda-augite shows pleochroism not so weakly, and is sometimes surrounded by hornblende. Biotite occurs not commonly. Well formed sphene and granular apatite, not rarely aggregated, are present in considerable amount. Ore minerals, probably magnetite, occur in contact with hornblende or augite. As secondary mineral, sericite is present.
304	D004	19B	PU	Shale	The rock shows laminated texture clearly and cemented with carbonate mineral (calcite). Grains up to 0.05mm in diameter also are observed, but most of all is occupied with argillaceous materials.
305	D008	19B	PU	Dolomite	The rock shows sparitic texture and is composed of mosaic of carbonate mineral (dolomite) anhedral. Other minerals also are contained but all of them are too altered to be identified.
306	D009	19B	PU	Dolomite	The rock is composed of mosaic of dolomite anhedral, and shows sparitic texture. Small (less than 0.05mm in size) opaque minerals are contained very rarely.
307	D012	19B	SA	Shale	The rock shows laminated texture and contain less than 10 percent of subangular to subrounded quartz grains (0.05mm or less in size). Sericite is also recognized rarely. Other portions are composed of argillaceous materials.
308	D017	18B	SA	Shale	The rock consisting of microcrystalline clay minerals is oriented so that tiny flakes are roughly parallel to lamination. Some subrounded silt-size grains of quartz are recognizable.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
309	D029	17C	CH	Limestone	As the whole, the rock shows microcrystalline (micritic) texture. A fissure (about 2mm in width) is filled up with sparitic carbonate minerals. Iron minerals are recognizable along some fissures, and terrigenous grains of quartz and feldspar also are contained. Possils as foraminiferas, molluscas, and calcareous algae are recognizable.
310	D030	17C	CH	Conglomerate	The rock is composed of limestone granules, quartz grains and altered feldspars. Grains are generally rounded to subrounded in shape. In Limestone granules, quartz grains are recognizable. Limestone granules are composed of mosaic of fine grained calcite anhedral.
311	D039	19E	HU	Mudstone	Angular to subangular grains of quartz, altered feldspars, and sericite are recognizable in argillaceous materials. The maximum diameter of quartz grains is about 0.3mm. Opeque minerals are contained rarely.
312	D045	13E	CH	Limestone	Carbonate mineral (calcite) occurs as microcrystalline mosaic and/or cement of silt-size grains of subrounded to subangular quartz, potash feldspar and plagioclase. As the whole, detrital grains account for up to 20 percent. The rock is considered to be impure limestone.
313	D058	13B	BC	Quartz schist	Fine grained lepidoblastic texture. Major constituent minerals are quartz, muscovite and clay minerals. Minor constituent minerals are feldspars, opaque minerals, zircon and sphene. Original structure of sandstone is well preserved. Subrounded to subangular quartz grains showing cataclastic features comprise 40% of the rock and the remainder is composed of lepidoblastic muscovite, minute quartz, feldspars, various clay minerals and opaque minerals. Trace amounts of zircon and sphene also occur.
314	D060	13B	PG	Biotite granite	Medium grained anhedral granular texture. Major constituent minerals are quartz, sodic plagioclase, microcline and biotite. Minor constituent minerals are sericite, epidote, chlorite, zircon, sphene, magnetite and hematite. Quartz grains show weak undulatory extinction. Albite twin is developed in sodic plagioclase. Some microcline grains are stained with minute sericite, epidote and sphene. Biotite is partly replaced by chlorite.
315	D061	13B	PG	Biotite granite	Medium grained subhedral granular texture. Major constituent minerals are quartz, microcline, oligoclase and biotite. Minor constituent minerals are sericite, epidote, chlorite, garnet, sphene, magnetite and hematite. Quartz grains show moderate undulatory extinction. Biotite grains often include magnetite, epidote and minor amounts of colorless garnet but chloritization is slight. Microcline is richer than oligoclase, and often includes small oligoclase and quartz. Some of them are perthitic.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
317	D064	13B	BC	Weathered phyllite	Fine grained lepidoblastic texture. Constituent minerals are quartz, muscovite, limonitic iron ore and clay minerals. Angular quartz grains, about 0.1mm in diameter, are distributed between films of muscovite and limonitic iron ore, and the latter two minerals form distinct foliation. Quartz grains show weak undulatory extinction. This sample is moderately weathered.
318	D065	13B	BC	Epidote amphibolite	Fine grained subhedral granular texture. Major constituent minerals are sodic plagioclase, green hornblende and epidote. Minor constituent minerals are biotite, sericite, garnet, sphene and magnetite. Schistosity is not distinct. Green hornblende and sodic plagioclase are the major constituents and anhedral epidote is also abundant. Very small (0.01mm) yellowish garnet (?), biotite, sericite, sphene and magnetite are disseminated among them. Epidote occurs also as veinlets.
319	D066	13B	BC	Epidote-quartz semischist	Major constituent minerals are quartz and epidote. Minor constituent minerals are biotite, microcline, sodic plagioclase, chlorite, zircon, sphene, clay minerals, magnetite, hematite and limonite. Fine grained poorly recrystallized rock of sandstone origin. Almost all clastic grains are made of quartz of about 0.2mm in average diameter. They show cataclastic features as cracks and undulatory extinction. Small amounts of alkali feldspars are recrystallized in the matrix. The abundance of small epidote grain is characteristic. Biotite is partly altered to chlorite.
320	D069	13B	PG	Sheared biotite granodiorite	The texture of this rock is hypidiomorphic fine grained; weakly porphyritic, protoclastic, partly cataclastic. Main constituent minerals are quartz, palgioclase, potash feldspar and biotite. As minor constituents, muscovite occurs. Quartz shows remarkable undulatory extinction. Plagioclase shows lamellar twinning commonly, and is moderately sericitized. Potash feldspar shows microcline structure not so uncommonly, and is scarcely sericitized. Biotite is completely altered to chlorite with sphene. As secondary mineral, calcite, sericite, chlorite and sphene are present. Along shear plane, calcite vein occurs.
321	D073	13C	MD	Biotite-hornblende quartz diorite	Medium grained anhedral granular texture. Major constituent minerals are plagioclase (andesine), quartz and hornblende. Minor constituent minerals are biotite, epidote, chlorite, apatite, calcite, ilmenite and magnetite. Quartz occurs as large interstitial crystal. Plagioclase is of andesine composition and hornblende is brownish green. Biotite is partly replaced by chlorite.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
322	D074	13C	MI	Dacitic fine tuff	Major constituent minerals are alkali feldspars and quartz. Minor constituent minerals are sphene, clay minerals and opaque minerals. Lithic ejecta are rare. Crystalline ejecta are mainly alkali feldspars, up to 2mm in diameter, generally stained with clay minerals. Quartz (chalcedony ?) occurs as patch like aggregate of minute anhedral crystals. Matrix is cryptocrystalline and opaque minerals are disseminated in it. quartz veinlets are abundant.
323	D075	13C	MD	Biotite granite	Medium grained anhedral granular texture. Major constituent minerals are quartz, microcline, sodic plagioclase and biotite. Minor constituent minerals are muscovite, sericite, chlorite, magnetite and pyrite. Quartz grains show moderate undelatory extinction. Microcline grains are generally stained with minute sericite flakes. Biotite is partly altered to chlorite.
324	D079	13C	MD	Muscovite-bearing biotite micro-adamellite	Main constituent minerals are plagioclase, quartz, potash feldspar and biotite. As minor constituents, muscovite occurs. Plagioclase is moderately zoned, partly sericitized, especially in core. Quartz shows undulatory extinction very commonly. Potash feldspar commonly shows perthite structure, rarely microcline structure is present. Biotite is sometimes altered to chlorite, inclusion of ore minerals and apatite is common. As secondary minerals, sericite, chlorite and epidote are present.
325	D081	13C	MD	Altered dacite	Very fine grained aphyric texture. Major constituent minerals are quartz, alkali feldspars, chlorite and sericite. Minor constituent minerals are epidote, sphene and hematite. Quartz and mafic mineral microphenocrysts of about 0.2mm in diameter are scattered in pilotaxitic groundmass. Microphenocrysts of mafic minerals are now completely altered to chlorite, or chlorite and hematite. The chlorite is light pale green or almost colorless under open nicol and is dark under crossed nicol. Alkali feldspars are altered to sericite aggregate.
326	D082	13C	MD	Hornblende (?)-muscovite-biotite granite	Medium grained subhedral granular texture. Major constituent minerals are hornblende (?), muscovite, sericite, epidote, chlorite, zircon, sphene, apatite, calcite and leucoxene. Quartz grains are almost underformed. Microcline are generally stained with sericite, calcite and leucoxene. Biotite is partly altered to chlorite. Subhedral pseudomorph, now composed of epidote and quartz may have originated in hornblende.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
327	D086	13D	MD	Altered biotite granite	Medium grained subhedral equigranular texture. Major constituent minerals are quartz, microcline, plagioclase (oligoclase) and biotite (altered to chlorite). Minor constituent minerals are chlorite, muscovite, sericite, sphene, zircon, calcite and magnetite. Some quartz grains show weak undulatory extinction. Microcline is generally stained with sericite flakes. Plagioclase is of oligoclase composition. Biotite is completely altered to chlorite, which shows purplish abnormal interference color. Thin calcite veinlets occur.
328	D087	13D	MD	Quartz porphyry	Phenocrysts are composed of quartz, sodic plagioclase, microcline, biotite(?) and hornblende (?). Groundmass is composed of sodic plagioclase, microcline, sericite, quartz, epidote, chlorite, apatite, sphene, leucoxene, magnetite and hematite. Quartz, sodic plagioclase, microcline, minor amounts of completely altered biotite (?) and hornblende (?) occur as phenocryst of 1mm in diameter. Euhedral to subhedral, in some case corroded or embayed, quartz phenocrysts are dominant among them. Biotite is altered to the aggregate of chlorite, epidote and sphene, but hornblende is altered to that of epidote and minor amounts of quartz. Microlites of sodic plagioclase, microcline, sericite and quartz comprise the groundmass of felty texture.
329	D089	13D	MT	Sandstone	The rock is coarse grained, poorly sorted, and is composed mainly of quartz, potash feldspar, plagioclase and cherty rock fragment. Assaccessory minerals, opaque minerals, carbonate mineral (calcite), and sericite of secondary origin are recognizable. Feldspar are altered partly to sericite or to be replaced with calcite.
341	KE001	6	MP	Biotite granite	The rock is hypidiomorphic and composed of plagioclase, potash feldspar, small quartz and biotite with accessory iron ore, apatite and sphene. Almost feldspar (potash feldspar and plagioclase) alters to kaolin by common decomposition. But, potash feldspar is recognized as orthoclase and perthite. Plagioclase shows albite twin. Quartz shows cataclastic figure. Fresh biotite is brown, with intense pleochroism. Along the basal cleavage, biotite changes to chlorite.
342	KE002	6	MP	Sandstone hornfels	The rock may be coarse to very coarse grained quartzose sandstone originally, composed mainly of subangular quartz grains. Tiny lath or thread like sericite, occurs reticulately by the thermal effect. A small quantity of sulfide mineral also occur irregularly.
344	KE012	10	CG	Hornblende augite gabbro	The rock shows hypidiomorphic texture. The main constituent minerals are plagioclase (subhedral, up to 1.5mm mainly labradorite), augite (subedral, up to 0.4 mm, CAZ 42° - 46°), brown hornblende (subhedral, up to 0.6mm, observed frequently in the marginal part of augite, with a pleochroism of Zmreddish brown, Xpale brown) and black magnetite (subhedral, up to 0.3mm). As the secondary mineral, fibrous epidote is recognized.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
347	REO40	16	CH	Dolomite	Very finely crystalline dolomite with subangular to angular silt-size grains of quartz less than 5% and a few per cent of ironic minerals. Original sediments may be lime mud with several per cent of silt.
361	RFOO6	4	PU	Dolomite	Very finely to finely crystalline dolomite. Pellet ghosts remain sporadically. Original sediments may be pelmicrite. The rock is crashed rather distinctly, and fractures filled by calcite and silica veins.
363	RFO13	6	PU	Dolomite	Very finely crystalline dolomite with several per cent of subangular silt-size quartz and ironic mineral. Original sediments may be micritic limestone with several per cent of silt.
364	RFO15	6	PU	Dolomitized calcareous chert	Composed mainly of medium grained micro-quartz but retaining fossil remains of foraminifera sporadically. Therefore, the rock is nodular or lenticular chert which was changed by replacement from foraminiferal micritic limestone. But calcite is wholly replaced by fine to medium grained rhombs of dolomite. Small amounts of ironic minerals are also observed sporadically.
365	RFO16	6	PU	Dolomitic limestone with chert nodule	Composed mainly of very fine to fine grained anhedral mosaic of dolomite, but retaining of structure of the original radiolarian biomicrite with foraminiferal tests. Nodular chert, composed of medium grained micro-quartz, replaced irregularly with original radiolarian biomicrite.
368	RFO19	4	TV	Biotite quartz porphyry	The rock shows porphyritic texture, but the groundmass is wholly glass. The constituent minerals are quarts (subhedral bipyramid, up to 0.8mm) and altered alkali - feldspar (up to 0.7mm, fine aggregate with kaoline and sericite). A few small biotite occurs as opacite. The pale green groundmass shows fluidal structure, and consists of fine tiny iron ore, glass and skelton crystal (may be quartz).
371	RFO34	11	PU	Dolomitized calcareous chert	The rock is composed mainly of coarse to medium grained anhedral mosaic of dolomite. Irregular chert, composed of fine to very fine grained micro-quartz, which was changed from limestone by replacement, occurs sporadically. Medium grained mosaic of dolomite also replaces with the calcareous part in the irregular chert.
372	RFO38	18	PU	Radiolarian biomicrite	Composed mainly of very finely crystalline micrite with radiolarian remaines and a few par cent of silt-size detrital quartz. Micritic limestone is replaced by very fine grained micro-quartz irregularly and sporadically.
373	RFO39	18	PU	Dolomitized biomicrite	The rock consists more than 50% of allochem grains of brachiopod shell, crinoid and bryozoan fragments, cemented by micro crystalline calcite, but fine grained anhedral mosaic and rhombus of dolomite occures sporadically and irregularly.
370	CFO33	11	PU	Dolomite	Fine to medium grained anhedral mosaic of dolomite in which are small amounts of the ghosts of fossil remain. The ghosts of fossil remain are composed of coarsely crystalline calcite.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
374	RP042	13	PU	Phyllitic limestone	The rock shows distinct schistoze structure and recrystallized limestone, but remains partly micritic texture. Secondary calcite grains are coarse to very coarse anhedral mosaic.
375	RP043	9	PU	Dolomite	The rock composed of coarsely crystalline dolomite, scattered throughout anhedral coarse mosaic of calcite.
376	RP044	9	PU	Dolomitic limestone	Medium crystalline dolomite scattered throughout anhedral coarse to medium mosaic of calcite.
377	RP047	9	PU	Micrite	The rock composed wholly of very finely crystalline calcite, but sporadically scattered coarse sparry calcite. The original sediments may be dismicrite.
380	RP050	11	PU	Dolomite	Medium to coarsely crystalline dolomite with coarsely recrystalline mosaic of calcite.
390	RP059	15	PU	Dolomitic oomicrite	The rock composed wholly of medium to coarsely recrystallized mosaic of calcite, but original structure of oolitic limestone is remained, and finely crystalline rhombus of dolomite occures between oolites irregularly.
391	RP061	15	CM	Reddish silty sandstone	Very fine grained angular to subrounded quartz and small amounts of feldspar are cemented by calcite and clay minerals. Clayey matrix is colored by hematite.
395	RP071	18	PU	Recrystallized limestone	The rock is composed wholly of very fine to coarse grained mosaic of calcite. It seems that the variation of grain size of mosaic is due to the difference in original grain of limestone, such as micrite, sparry calcite and fossil remains.
398	RP075	11	PU	Sandy siltstone or shale	Very fine subangular to subrounded grains of quartz and small amounts of feldspar are cemented by clayey matrix. Rich carbonaceous matter is observed in clayey matrix. Sand-size grain less than 35%.
453	RG005	4	PU	Pelsparite	Rounded aggregates of "algal" pellets in various size are cemented by medium crystalline sparry clacite. The specimen is somewhat recrystallized and dolomitized.
454	RG009	4	MP	Tuff	Subhedral β-quartz (up to 0.6mm), euhedral plagioclase (Oligoclase - Andesine, up to 0.35mm), irregular formed pumice (up to 0.7mm) and small irregular pebble of andesite are in a fine volcanic ash. Constituent minerals are quartz and plagioclase. Andesite pebble is pyroxene andesite. The part of this specimen shows tiny fluidal texture as like as welded tuff.
455	RG011	4	PU	Dolomitic biomicrite	The rock shows incipient dolomitization of crystalline limestone. The limestone is composed largely of finely to medium crystalline calcite, but remains ghosts of shell fragments and micritic structure sporadically. Very finely crystalline dolomite occurs in micritic matrix and along the margin of shell fragments by replacement.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
456	RG021	6	PU	Dolomitic limestone	Aphanotic to very finely crystalline dolomitic micrite with several per cent of very fine grained detrital quartz.
458	RG062	1	PU	Dolimitised radiolarian micrite	Containing abundant radiolaria with a micrite matrix. Radiolarian remains are entirely replaced by micro-quartz. Aphanotic to very tine dolomite crystals are disseminated in the micrite.
459	RG072	12	PU	Calcareous silt stone	Containing abundant radiolarian remains and very fine grained detrital quartz with calcareous silt matrix. Radiolarian remains are entirely replaced by calcite. Detrital quartz are angular to subrounded and poorly sorted. Matrix consists of aphanotic to very finely crystalline calcite and clayey matter.
460	RG073	12	OR	Arkose sandstone	Coarse grained sandstone is composed chiefly of quartz (more than 80%) and lesser amounts of potash feldspar (less than 10%), cemented with secondary quartz and clayey minerals. Quartz grains in coarser facies show secondary rim. A few per cent of recrystallized quartz grains are observed. Clayey materials change to thread like sericite.
462	RG087	13	CG	Biotite granite	The rock shows a medium grained granular texture. The main constituent minerals are quartz (subhedral, up to 1.3mm), alkali feldspar (euhedral, up to 1.0mm" twinned after Carlsbad law, microcline and perthite, some of them show granophyric texture), biotite (anhedral, up to 0.5mm, including magnetite and sphene, at the marginal part and along cleavage it changes to pale green chlorite). A quantity of plagioclase (subhedral, up to 0.4mm, oligoclase) is small. Sphene is seen as accessory mineral. Chlorite after biotite and clay mineral, and sericite after feldspar are seen as the secondary mineral.
463	RG089	13	PU	Dolomitic limestone	The rock consists mainly of coarsely recrystallized calcite with medium grained detrital quartz, but finely to medium crystalline dolomite replaced about 60% of calcite.
464	RG091	13	PU	Crystalline limestone	The rock shows distinct schistose structure, and consists of finely recrystalline calcite and numerous calcite vein.
465	RG105	14	PU	Calcareous silt stone	The rock shows nearly same character as RG 072, but more coarsely recrystallized.
466	RG106	14	PU	Silicified rock	The original rock is acidic volcanic ash or acidic tuff. The rock is perfectly gotten the silicification, and consists of very small quartz grain, sericite and clay mineral. A small quartz vein is recognized.
467	RG111	14	PU	Biomicrite	Rounded shell fragments of bivalves, gastropods and other fossil remains are cemented by muddy micrite originally, but changed to very finely to finely crystalline calcite by recrystallization.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
469	KG118	16	PU	Tuff	The rock is gray in colour and consists of very fine volcanic substances. They are quartz, volcanic ash and glass. Phenocrystic fragments, such as quartz, feldspar etc., are not seen. After alteration, a small quantity of sericite occurs along the space.
470	KG120	19	PU	Glauconitic dolomite	Very fine to fine grained porphyroblasts of dolomite scattered throughout anhedral mosaic of calcite in which are numerous glauconite grains and about 10% of detrital quartz. Glauconite granules, alterated to brown color, show patial replacement by dolomite.
496	KH001	7	PU	Silisified conglomeratic limestone	Consists of subangular to rounded granule and very coarse sand - size grains of orthoquartzite, recrystallized chert and a few of much altered andesite with very coarsely crystallized sparry calcite matrix. The matrix is replaced partly by micro-quartz by silisification. Tiny lath shaped sericite is scattered in matrix of micro-quartz. Sericite and chlorite are also scattered in volcanic fragments.
497	KH002	7	PU	Brecciatted biomicrite	The rock is composed of very finely crystallized mosaic of calcite with fossil remains of gastropod and crinoid, and crashed distinctly. The fractures are filled by coarsely crystallized calcite.
498	KH019	8	MP	Biotite quartz porphyry	The rock is porphyritic. Phenocrysts of quartz (subhedral, 0.65 - 2.20 mm long, quartz partly corroded and contains gas cavity), alkali feldspar (euhedral or subhedral, up to 1.0 mm, sanidine almost altered to sericite and clay mineral)and biotite (euhedral subhedral, up to 0.20 x 0.45 mm, perfectly altered to opacite or chlorite). The groundmass is fine texture and consists of very small quartz grain and glass. A narrow quartz vein is seen one. The rock altered by thermal efect slightly.
500	KH028	8	OR	Medium sandstone	Well sorted, subangular to rounded medium grains of quartz, chert and silt stone are cemented with a very small quantity of micro-quartz and clay mineral. Tiny lath shaped sericite is scattered in the detrital silt stone grain and matrix. The rock may be originated from quartzose sandstone and silt stone.
501	KH030A	10	CG	Biotite granite	The rock shows a medium grained and granular texture. The main constituent minerals are quartz (subhedral-anhedral,up to 0.65 x 0.85 mm, rarely showing the wavy extinction), alkali feldspar(euhedral-subhedral, perthite and microcline, up to 0.25 x 0.55 mm, often showing as the marginal part of plagioclase), plagioclase (subhedral, up to 1.60 x 0.70 mm, all alters to the fine mixture of kaolinite and sericite, albite twin is slightly recognized), and biotite (anhedral, up to 0.37 x 0.67 mm, perfectly altered to clinozoicite, small irregular black magnetite is seen as inclusion). Apatite, zircon and iron as like accessory minerals are very poor.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
502	RH030B	10	CG	Micro muscovite granite	The rock shows a fine grained and micro granular texture. The main constituent minerals are quartz (anhedral, up to 0.18 x 0.25 mm, often showing the wavy extinction, corroded), alkali feldspar (subhedral-anhedral, up to 0.30 x 0.23 mm, often showing the exsolution phenomenon, some of them altered to clay mineral and sericite), plagioclase (euhedral-subhedral, up to 0.25 x 0.18 mm, main part is oligoclase, some of them altered to clay mineral and sericite) and muscovite (anhedral and small lenticular form, up to 0.33 x 0.10 mm, altered to chlorite). Iron ore (magnetite) is seen. Accessory minerals can not seen. Chlorite, sericite, clay minerals and limonite occur as the secondary mineral.
503	OH038	12	PU	Silicified rock	The original rock is andesitic tuff. Silicification is perfect. Phenocrystic volcanic fragment is only pyroxene and calcite. Very fine volcanic substances are quartz grain, euhedral plagioclase, volcanic glass and black iron ore.
505	RH040	12	TM	Hornblende porphyrite	The rock is porphyritic. Phenocrysts of plagioclase (euhedral-subhedral, up to 0.7 x 0.2 mm, altered to clay minerals perfectly) and hornblende (euhedral, 0.1 x 0.2 - 0.45 x 1.60 mm, altered to calcite perfectly). Very small sericite occurs in the groundmass as secondary mineral.
506	RH050	18	MI	Arkose sandstone	Rather well - sorted, angular to subrounded, medium to coarse grained fragments of quartz, alkali feldspar (perthite and microcline), plagioclase (oligoclase), a small amounts of chert are cemented by silty matrix and limonite. Kaolinite, sericite and very small quantity of chlorite occur in feldspar grains and matrix by alteration.
507	RH051	15	CH	Calcareous sandstone	Poorly sorted, fine to medium garined, angular to subrounded fragments of quartz, a small amounts of plagioclase and chert are cemented with coarsely crystallized calcite and clayey matrix. Clayey matrix is colored to redish brown by limonite.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
568	RI005	4	OR	Pelsparite	Poorly sorted pellets, foraminifera and algaldebris are cemented irregularly by fine to medium grained mosaic of sparry calcite. Pellets of diverse size are present throughout the slide, ranging from 0.02mm to 1.0mm or more.
569	RI012	5	PU	Tuffaceous sandstone	Poorly sorted medium to coarse grained sandstone with tuffaceous silt matrix. Sand grains consists mainly of quarts, a small amounts of plagioclase and much altered andesite fragments. Fine matris, like a clay paste, composed of comminuted mineral grains and devitrified glass.
570	RI033	7	PU	Dolomitic limestone	Coarsely recrystallized mosaic of calcite is replaced wholly by fine to medium grained dolomite. A few per cent of angular detrital quartz is observed sporadically. The rock is intruded irregularly by quartz vein.
571	RI043	7	PU	Dolomitic limestone	The rock is composed mainly of very coarsely recrystallized mosaic of calcite, more or less dolomitized.
572	RI044	7	PU	Dolomitic limestone	The rock composed of rather uniformly recrystallized medium grained mosaic of calcite, and is changed to fine grained dolomite selectively along a layer of finer mosaic of calcite. Original rock can be considered to a lamineted limestone, consists of micrite and sparite. Dolomitization was progressed selectively in the micritic layer.
573	RI048	7	PU	Dolomitic limestone	The rock consists mainly of finely recrystallized mosaic of calcite, but about half of them are changed to very fine anhedral mosaic of dolomite by replacement. Numerous coarse grains of calcite are observed sporadically. They seem to be the ghosts of fossil fragments.
578	RI066B	1	CR	Silty sandstone sandstone	About 65% of angular to subrounded very fine grains of quartz (more than 85%), feldspar (potash - feldspar and plagioclase, about 10%) and fragments of chert and andesite are cemented with rather coarse silt matrix. Tiny lath like sericite and chlorite are scattered in the matrix. Matrix is colored to redish brown by hematite.
576	RI060B	1	PU	Cataclastic quartzose sandstone	The rock consists of distinctly crashed very coarse grains of quartz and a few of recrystallized chert fragments, which show wavy extention, with micro-quartz matrix. Tiny lath like sericite is scattered in the matrix. Origin of micro-quartz can not be decided to fault clay, siliceous sediments or secondary silicification.

Sample No.	Field No.	Locality	Formation	Rock Name	Microscopic Observation
580	RI086	19	MD	Quartz augite hornblende diorite	The rock shows a medium grained and hypidomorphic texture. The main constituent minerals are quartz (anhedral, up to 0.2mm), plagioclase (up to 0.3 mm, mainly andesine, almost changes to kaolinite and sericite, subhedral), brown hornblende (subhedral, up to 0.6 mm, pleochroism weak) and augite (euhedral prismatic, up to 0.4 mm, marginal part changes to hornblende, CAZ 38 - 42). Apatite is common and small magnetite grain is rare as accsessory mineral. The rock is not fresh and is accepted thermal effect.
585	RI102	15	CH	Muscovite biotite bearing granite	The rock shows a medium grained and hypidiomorphic texture. The main costituent minerals are quartz (anhedral, up to 0.3 mm, often shows the wavy extinction), and alkali feldspar (euhedral, up to 0.35 x 0.40 mm, almost changes to clay mineral). Muscovite and biotite are the minor or accessory mineral. Some part of biotite change to chlorite. Apatite occurs in alkali feldspar as an inclusion. A few magnetite is recognized.
586	RI103	15	CH	Biotite hornblende porphyrite	The rock is porphyritic. Phenocrysts of plagioclase (euhedral and subhedral, up to 0.8 mm long, distinctly zoned, mainly andesine but having the core of labradorite, twinned after albite and carlsbad law), biotite (anhedral, up to 0.5 mm with a pleochroism of X=yellow, Y=Z=pale green, partly altered to chlorite), hornblednde (subhedral, up to 0.15 x 0.40 mm, almost altered to biotite and chlorite) and dark orange sphene (euhedral, up to 0.05 mm, max=0.7 mm long). Slender needle ilmenite and irregular magnetite are small. The groundmass is holocrystalline with a fine texture, and consists of only lath shaped plagioclase. In general, very small sericite as the secondary minerals is scattered.
588	RI122	15	PU	Echinoidal biomicrite	Consists almost wholly of crystalline crinoid and echinoid debris cemented by very finely crystallized mosaic of calcite.
590	RI133	16	PU	Dolomitic pelmicrite	Consists almost of ghosts of pellets, varying in size and shape, and of small amounts of foraminifera with very fine micritic matrix. Fine rhombs of dolomite is scattered in the ghosts of pellets selectively.
591	RI134	16	CH	Dolomite	Very finely crystalline anhedral mosaic of dolomite in which are remained ghosts of pellets and coarsely recrystallized clinoid debris. A few per cent of angular fine grained detrital quartz is observed.
592	RI141	19	PU	Conglomeratic limestone	Consists of angular to subrounded, pebble to granule sized intraclasts, andesite and andesitic tuff fragments with very coarsely crystalline sparry calcite matrix. Intraclasts includs oomicrite, radiolarian biomicrite, algal biomicrite and crinoidal biosparite. Detrital grains of andesite and andesitic tuff are altered distinctly. Coarse grained subrounded detrital quartz and chert are obserued.

Table 7. Microscopic Observation of the Polished Sectione

Sample No.	Field No.	Locality	Types of Mineralization	Reflecting Microscopic Observation
	Pb Ore			
349	OE 287	18	Float of silicified limestone with dissemination galena.	The specimen is composed mostly only galena as ore mineral accompanying with some gangue minerals. Galena shows clear white in reflecting color, isotropic, and associates closely with fine bladed shaped gangue minerals as shown in Fig. 12-1. Typical triangular cleavage pits seen generally in galena are not developed in this specimen. Fine idiomorphic cubic crystals of pyrite, maximum about 50 μ and usually 10 to 20 μ in size, are observed among both galena and gangue minerals. Sometimes they aggregate each other to form cluster grains of pyrite as large as 0.4 mm in size.
351	OE 289	18	Galena ore of Pichita Caluga Mine.	In this specimen several small galena grains are observed megascopically on the polished surface. Under the ore microscope, tiny pyrite grains and galena in various sizes are observed through out the polish surface. Galena occurs irregular shape, about 1 mm in maximum size and 30 to 200 μ in general size, and shows pure white color. Outer part, near grain boundary of galena masses are replaced by dark gray colored fine gangue minerals(?) and then shows like dendritic or dusted textures as shown in Fig. 12-1. This dark gray non-opaque mineral is also found among true gangue minerals, might be dolomite, and it usually contains very fine dusty galena less than 1 μ. This mineral shows modelate reflecting pleochroism and distinct anisotropism under closed nicols. The mineral could not identified certainly, but it might be in high possibility cerussite because of the similar occurrences to that of smithsonite in zinc ore mentioned below. Pyrite, occurs as cube or subhedral crystal in size of 5 to 30 μ. So many fine pyrite grains disseminated through out the specimen but their occurrence and distribution are in close relation with dark gray anisotropic non-opaque minerals mentioned above. Pyrite is also found in galena, and sometimes observed as aggregate grains of several hundreds microns.
366	OP 017	6	Galena ore of Pichita Caluga Mine.	Among dark brown colored rock specimen two clear galena masses as large as 3 to 5 mm are observed megascopically. Galena occurs as interstitial filling forms among idiomorphic gangue minerals a shown in Fig. 12-2. Reflecting color is pure white and no alternation and no inclusion mineral are found in galena. Pyrite is not so many in this specimen but several iron hydroxide might be goethite, grains which replaced former pyrite crystals are found in gangue. They show various tint of gray in heterogeneous color, 0.1 mm in maximum and 20 to 50 μ in general sizes, and contain tiny pyrite grain within them in most cases. A small amounts of sphalerite are also observed as irregular shape of 0.6 to 0.8 mm in size among gangue minerals.
367	OP 018	6	Galena ore of Pichita Caluga Mine.	The specimen is massive galena ore. Except some small gangue masses, galena does not contain any other ore minerals even pyrite in this specimen. Several veinlet of non-opaque minerals, 10 to 30 μ in width, cut across galena and galena is replaced slightly around the veinlet.

Sample No.	Field No.	Locality	Type of Mineralization	Reflecting Microscopic Observation
397	OP 073	16	Float of galena ore.	This specimen is also massive galena ore. Galena crystals in the specimen OP 073 show a deformation texture under the ore microscope. It is observed that a regular arrangement of well developed typical triangular cleavage pits is disturbed and bented as shown in Fig. 12-2. No gangue and no other sulfide minerals are found in galena.
457	OG 027	7	Float of grey dolomite with spotted galena and sphalerite in calcite vein.	Several fine veinlets of galena and gangue minerals run nearly in parallel among dark color rock specimen. The veinlets consist mainly of galena accompanying with sphalerite and gangue minerals and their width are 0.2 to 0.3 mm in general and 1 mm in maximum. Among gangue matrix euhedral crystals of pyrite, 20 to 50 u in size, are found and they sometimes rimmed or replaced irregularly by goethite. Goethite shows gray in reflecting color and reddish to brownish internal reflection.
	Zn Ore			
393	OP 064	15	Partly limonitized zebra dolomite with very weak dissemination sphalerite.	Over a half area of the polished surface is occupied by dull brownish colored sphalerite. Under the ore microscope sphalerite in the specimen OP 064, as same as that in other specimens, has a rather higher reflectivity than usual sphalerite and then it shows extremely light color, pale grayish white with a little brownish tint. Reflecting pleochroism is not observed but milky grayish white to yellowish or pale brownish color of internal reflections are usually observed between closed nicols. It was difficult to identify the mineral at first because of its light color, but results of X-ray diffraction studies showed the mineral to be surely sphalerite. After qualitative analyses by a electron probe microanalyser this sphalerite contains little iron. Grain boundary with gangue minerals is mostly sharp, however, when light gray non-opaque minerals, might be smithsonite, contact with sphalerite the former often replaces the later slightly. And some grain boundary of sphalerite is rimmed by fine grains of secondary crystallized pyrite as shown in Fig. 12-4. Pyrite disseminates as fine grains in gangue matrix, 5 to 20 μ in general size, but several large or aggregated crystals as large al 160 μ are also found. They are mostly replaced by goethite and/or siderite. Goethite shows grayish color with various tint and usually presents internal reflection of reddish to brownish color between closed nicols. Smithsonite occurs as veinlet of 30 to 100 μ in width cutting across sphalerite and as granular masses in gangue matrix. Color is light brownish gray, lighter than true gangue and reflecting pleochroism can be recognized. A distinct internal reflections of milky white, fancy yellow or brownish color are generally observed under closed nicols.

Sample No.	Field No.	Locality	Type of Mineralization	Reflecting Microscopic Observation
384 386 387 388 389	OP 053 OP 055 OP 056 OP 057 OP 058	15 15 15 15 15	Partly limonitized zebra dolomite with very weak dissemination sphalerite.	These five specimens of OP 053, OP 055, OP 056, OP 057, and OP 058 are almost similar to the specimen OP 064 mentioned above in mineral assemblage and their occurrences. Only sphalerite is main opaque mineral in these samples and their optical properties are identical. They occur as vein like or granular masses in several milimeter size and any other mineral inclusions is not found inside sphalerite grains. They show light grayish white with a little brownish tint in reflecting color without pleochroism. Internal reflections are usually observed. In many cases they are replaced by light brownish gray non-opaque mineral, smithsonite, and show "scratched dirty" or like mylmekitic texture as shown in Fig. 12-3. X-ray studies were carried on the non-opaque mineral, scratched out by a needle point from the polished surface of the specimen OP 064, then they were identified to be smithsonite. Smithsonite is lighter than other true gangue in reflecting color and presents characteristic internal reflections of fancy milk white with brownish yellow color. It contains often fine dusty inclusions of sphalerite. Replacement texture is well observed on the specimens of OP 055 and OP 056. Except sphalerite fine grains of pyrite and tiny iron hydroxide, formed after results of secondary replacements of pyrite are found among gangue matrix. In the specimen OP 056 some sphalerite grains are rimmed by fine pyrite crystals. Relative amount of sphalerite is much larger in the specimens OP 055 and OP 058 and the specimen OP 055 is abundant in smithsonite.
461	OC 079	18	Float of pinkish silicified rock with dissemination pyrite and sphalerite.	Sphalerite, galena, arsenopyrite, and chalcopyrite are observed under the ore microscope but sphalerite most abounds among them and arsenopyrite follows next. Sphalerite in this specimen shows graycolor with some bluish tinge as same as unsual sphalerite containing some iron. Many exsolved fine chalcopyrite dods, 3 to 10 u in general size, are found through out sphalerite and small grains galena also contained in sphalerite. Arsenopyrite occurs as separate grain in size of 0.1 to 2.0 mm in general, but sometimes contact with sphalerite. Chalcopyrite and galena are not found except in sphalerite.
	Cu Ore			
293	A 024	14C	Quartz veinlets in limestone.	Under the ore microscope several grayish white mineral of 600 to 300 u in maximum and 100 to 200 u in average size are found Constituent elements of this mineral were determined as Cu, As, and S including slight quantity of Fe and Zn as a result of quantitative analysis by electron micro probe analyzer and it is supposed to be tennantite. Tennantite has well polished smooth surface and occurs as irregular shaped grains in gangue matrix. Its color is light white with slightly yellow or olive tint and neither anisotropism and internal reflection is observed. Some gangue mineral and euhedral crystal of arsenopyrite are sometimes in cluded in tennantite, and chalcocite and flake crystal of covellite often replace partialy tennantite in near grain boundary. Arsenopyrite is also observed as idiomorphic grains, sometimes in beautiful hexagonal-form, of 5 to 20 μ in size. Pyrite is not found frequently by sometimes it occurs as radial aggregategain of 0.1 to 2 mm and very often replaced secondary by iron hydroxide. Chalcopyrite is not many but a few grains of below 100 μ, replaced by secondary chalcocite are observed.

Sample No.	Field No.	Locality	Type of Mineralization	Reflecting Microscopic Observation
350	OE 288	18	Green oxidized copper ore (Pichita Caluga Mine).	The specimen is an oxidized copper ore, and green and blue mineral such as malachite and azurite are observed megascopocally. Irregular shaped grains of chalcopyrite and tennantite are seen scattering in gangue matrix under the microscope. Tennantite has very smooth polished surface and shows white with yellow tint as the specimen A 024 in color. It often contains very small or reasonable sized grains of chalcopyrite. As mentioned above chalcopyrite occurs associated with tennantite but often separately observed in gangue as grains below 300 μ. It is replaced by chalcocite without exception and it often occurs that only small chalcopyrite remains in bluish gray chalcocite grains.
396	OF 072	18	Dissemination copper oxide in silicified limestone.	Two sulfide grains of about 1 mm size are observed megascopically among the smoky grayish white rock specimen. At preliminary microscopic observation the sulfide grains looks white or bluish white but under observation in detail it is distinguished the color is changing from white at the outer part through pale bluish white to light orange at the inner part of the grain. White part shows weak or moderate anisotropism of which color changes bluish gray to pinkish gray, but bluish white and orange parts are nearly isotropic. Under the qualitative analysis by electron probe microanalyzer the outmost white part contains only Cu and S, and Fe content increases with the color gradually change from bluish to orange. From these data it seems that these white, bluish, and orange phases correspond to chalcocite, digenite and bornite like minerals respectively. Some of the small grains of pyrite are observed in gangue matrix but no other sulfide such as chalcopyrite is found.
504	OH 039	12	Float of blue green altered limestone with dissemination pyrite and galena.	The sulfide grain about 2 mm in size if seen in the pale yellowish green rock with the unaided eye. The largest ore mineral under the microscope is arsenopyrite, about 1.5 to 2 mm, which has irregular shape filling up interstitially the subedral crystals of gangue minerals. Its color is creamy white and reflection pleochroism is scarcely observed. Under closed nicols rather strong anisotropism changing color from bluish gray to reddish brown is observed. Chalcopyrite is separately found among gangue as a very fine grain.
579	OI 082	19	Dissemination of chalcopyrite, malachite and sphalerite.	The yellow sulfide grains below 3 mm in size are found megascopically on the polished surface of the brownish rock specimen. The sulfide grains mainly composed of chalcopyrite, and are classified into two types; the grain being consist of only chalcopyrite or chalcopyrite replaced by chalcocite and the grain of chalcopyrite and pyrite. An independent chalcopyrite grain, in general, is replaced at the outer zone of the grain by chalcocite and/or is cut across by chalcocite-covellite veinlet. When the veinlet has considerable width a center part of the vein is replaced by goethite and fine covellite flake crystals are found near the replacement front. Smaller grains are almost completely replaced by chalcocite and smetimes only tiny relict of chalcopyrite is found. The grain of chalcopyrite coexisting with pyrite is usually not replaced. Pyrite is rather round subhedral crystal of 50 to 300 μ and chalcopyrite cements interstitially pyrite grains. Small separate pyrite is sometimes observed among gangue but often it is partly replaced by iron hydroxide as goethite.

Sample No.	Field No.	Locality	Type of Mineralization	Reflecting Microscopic Observation
292	A 023	14C	Dissemination in limestone.	No sulfide is found megascopically among the dark brown fine rock specimen but under the ore microscope various type of small sulfide grains of 300 u in maximum and several tens microns in general size are observed, though the quantity is not much. They are chalcopyrite-pyrite grain, tennantite-chalcopyrite-arsenopyrite grain, sphalerite-chalcopyrite grain, galena grain, chalcopyrite-chalcocite grain, spherical pyrite grain, etc. Chalcopyrite-pyrite, and tennantite-chalcopyrite grains are the richest among them. Spherulite pyrite scatters in gangue matrix and its size is 25 μ in maximum and 3 to 10 μ in general size. Optical properties of the individual minerals are the same as mentioned before.
	Limonite gossan			
316	D 063	13B	Limonite vein in schist.	These three specimens of D 063, OE 050, and OF 050 are limonite gossan and a texture and optical properties are almost identical. They consist of mostly low grade crystallized iron hydroxide minerals and then it hard to identify individual minerals. They show generally gray color with various tone of brownish tint and partly light color to white. At the limited portion, goethite needle crystals, skeltal texture of hematite, or some network structure are observed. They show also distinct internal reflections of reddish to brownish color under closed nicols. No sulfide minerals is found.
348	OE 050	16	Limestone gossan in the pucara group.	
381	OF 050	15	Pyrite lens in brecciated fine grained dolomite.	
	Rocks with little (or a little) ore minerals			
220	S 014	18B	Crystalline dolomite.	Any ore minerals are not recognized in the specimen.
259	C 013A	16A	Zebra dolomite.	The specimen is composed iron hydroxides (might be goethite) and some pyrite grains of under 100 u in diameter. Pyrite rarely occurs irregular shape and as relict mineral of alteration in iron hydroxide minerals.
264	C 021	13C	Zebra dolomite.	The 1 μ grained pyrite like minerals are only recognized in the small amounts.
279	A 002	19B	Zebra dolomite.	The 1 μ grained pyrite like minerals are only recogaized in the small amounts.
294	A 025	14C	Vein in limestone.	The very few amounts of euhedral pyrite crystals are recognized in gangue. The grain is 5 to 10 μ in general size, and rarely 30 μ in maximum size. Large crystals of pyrite are rimmed or replaced irregularly by goethite.
306	D 009	19B	Zebra dolomite.	Pyrite grains of several microns in size are rarely recognized in gangue.
362	OF 007	4	Dark gray limestone with impregnation galena.	Pyrite grains of under 10 μ in size scatter in gangue. At the center of goethite grain of several tens microns in size, pyrite grains are recognized as the relict after alteration.
383	OF 052	15	Limonitized zone in zebra dolomite.	Goethite grains of several hundreds microns in maximum size are recognized in gangue. Some goethites are replaced by siderite along the cracks, that seem like a veinlet.
385	OF 054	15	Limonitized zone in zebra dolomite.	Pyrite and goethite grains of 5 to 10 μ in general and 30 μ in maximum size are recognized.
468	OG 116	16	Zebra dolomite.	Any ore minerals are not recognized.

Fig 12 Microphotographs of Rocks and Ores

Thin sections

Sample No.	Field No.	Locality	Formation	Rock name
215	S003	18B	CH	Limestone
224	S022	20B	HU	Sandstone
229	B001	7G	TM	Soda-augite hornblende monzonite porphyry
240	B018	14C	MD	Metadolerite
243	B021	14C	MD	Altered andesite
246	B024	14B	MD	Porphyrite
249	B028-1	16B	PU	Dolomite
251	B029	14D	VI	Sandstone
254	C004	19C	TM	Altered porphyritic andesite
261	C015	10D	PG	Biotite granodiorite
266	C023	13D	MI	Shale
271	C028	11D	PG	Biotite hornblende diorite
273	C030	12D	MI	Dacitic welded tuff
283	A010	14B	MI	Conglomerate
287	A016	14B	PG	Biotite hornblende diorite
288	A017	14B	PG	Garnet biotite muscovite gneiss
294	A025	14C	PU	Limestone
301	A037	19B	TM	Soda-augite hornblende monzonite
309	D029	17C	CH	Limestone
312	D045	13E	CH	Limestone
313	D058	13B	BC	Quartz shist
318	D065	13B	BC	Epidote amphibolite
320	D069	13B	DQ	Sheared biotite granodiorite
324	D079	13C	MD	Muscovite bearing biotite micro-adamellite
329	D089	13D	MI	Sandstone
341	RE001	6	MP	Biotite granite
342	RE002	6	MP	Sandstone hornfels
344	RE012	10	CG	Hornblende augite gabbro
368	RF019	4	TV	Biotite quartz porphyry

Sample No.	Field No.	Locality	Formation	Rock name
454	RG009	4	MD	Tuff
462	RG087	13	CG	Biotite granite
466	RG106	14	PU	Silicified rock
469	RG118	16	PU	Tuff
496	RH001	7	PU	Silicified conglomeratic limestone
498	RH019	8	MP	Biotite quartz porphyry
501	RH030A	10	CG	Biotite granite
502	RH030B	10	CG	Micro muscovite granite
503	OH038	12	PU	Silicified rock
505	RH040	12	TM	Hornblende porphyrite
506	RH050	18	MI	Arkose sandstone
568	RI005	4	OR	Pelsparite
580	RI086	19	MD	Quartz augite hornblende diorite
586	RI103	15	CH	Biotite hornblende porphyrite
588	RI122	15	PU	Echinoidal biomicrite
592	RI141	19	PU	Conglomeratic limestone

Abbreviations

o Minerals

af : alkali feldspar
ap : apatite
au : augite
bi : biotite
c : calcite
ch : chlorite
d : dolomite
ep : epidote
g : glass
ho : hornblende
k : kaoline
mg : magnetite
ms : muscovite
pf : potash feldspar
pl : plagioclase
q : quartz
s : sericite
sd : sanidine
sp : sphene
spr: sparite

o Fossils

al : calcareous algae
fo : foraminiferas

Polished Sections

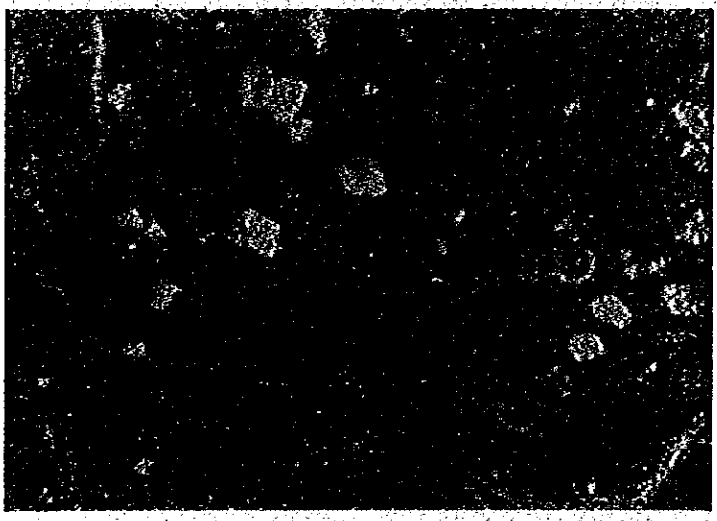
Sample No.	Field No.	Locality	Formation	Ore
349	OE 287	18	PU	Pb-ore
351	OE 289	18	"	
366	OF 017	6	"	
397	OF 073	16	"	
457	OG 027	7	"	
384	OF 053	15	"	Zn-ore
388	OF 057	"	"	
393	OF 064	"	"	
461	OG 079	18	MD	
293	A 024	14C	-	Cu-ore
579	OI 082	19	MD	
350	OE 288	18	PU	
396	OF 072	"	"	
579	OI 082	19	MD	
292	A 023	14C	PU	
316	D 063	13B	-	Limonite gossan
381	OF 050	15	PU	

215-S003, 18B,
CH
Limestone

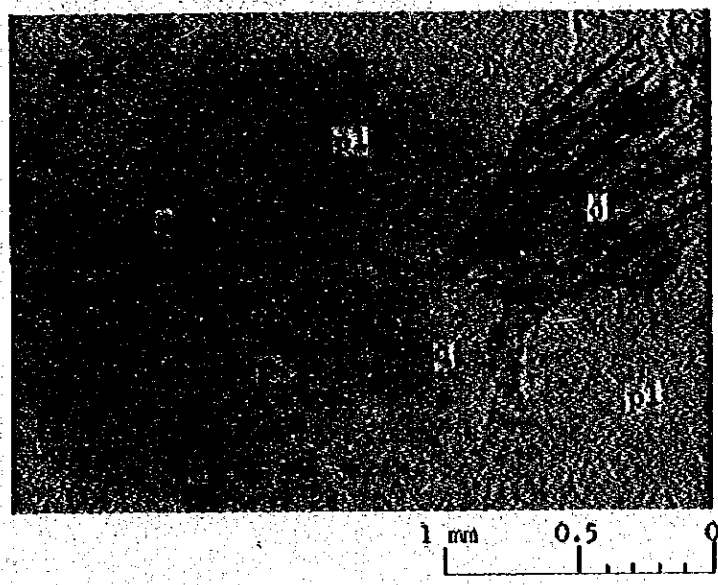
x 100

0.5 mm 0

Microcrystalline texture
Minerals : quartz feldspar
Possils : foraminiferas



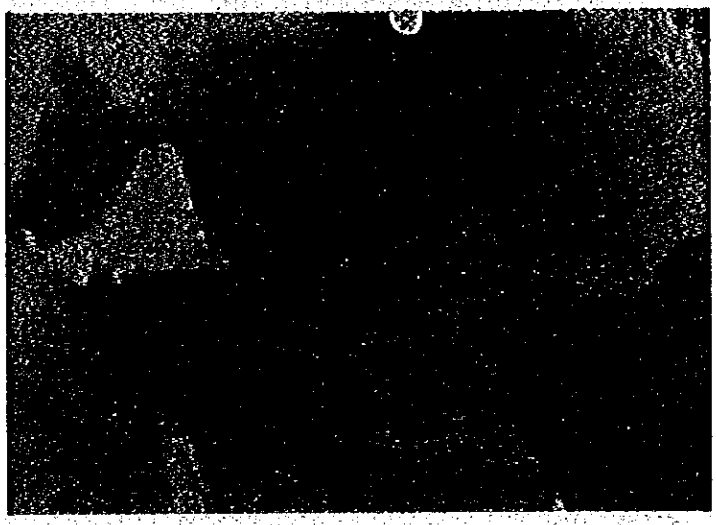
Crossed nicols



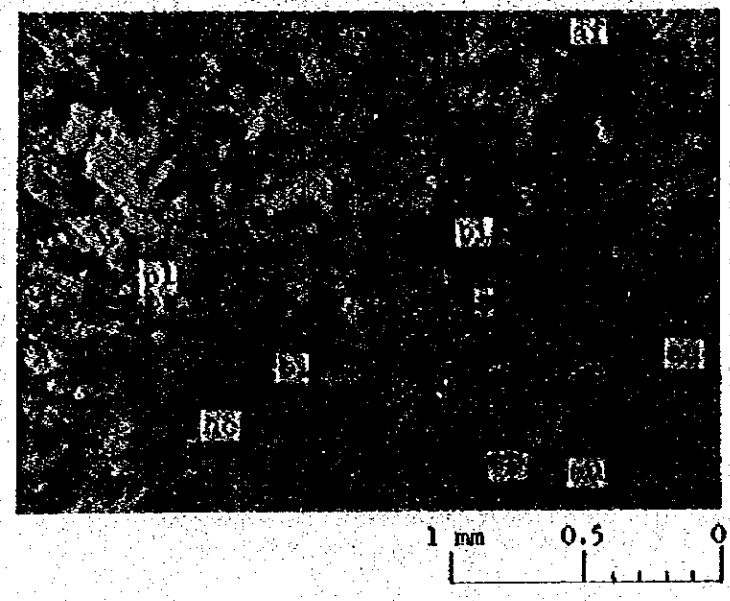
224-S022, 20B,
HU
Sandstone

x 40

Very coarse to coarse grained sandstone
Minerals : Quartz, potash foldspar, plagioclase, sericite, calcite



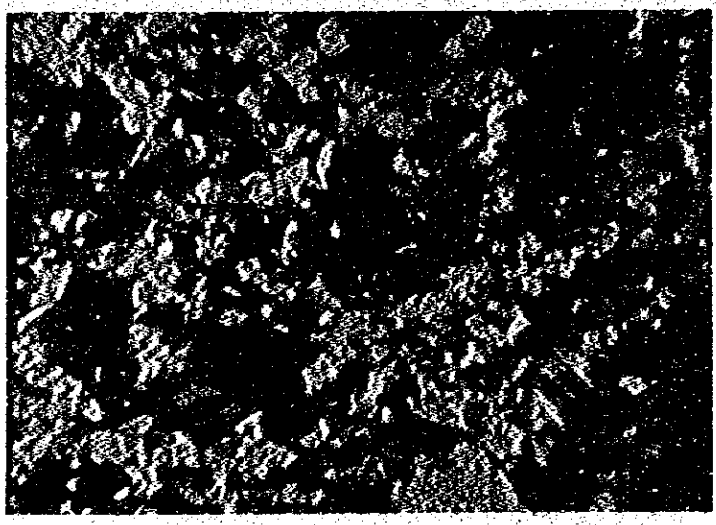
Crossed nicols



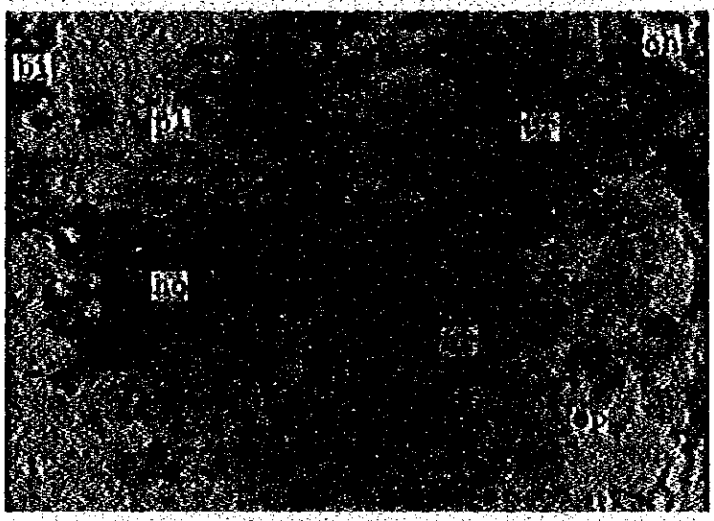
229-B001, 7G,
TM
Soda-augite hornblende
monzonite porphyry

x 40

Porphyritic texture
Minerals : Plagioclase, alkali feldspar, hornblende
soda-augite, biotite
Alteration minerals : epidote, sericite



Crossed nicols



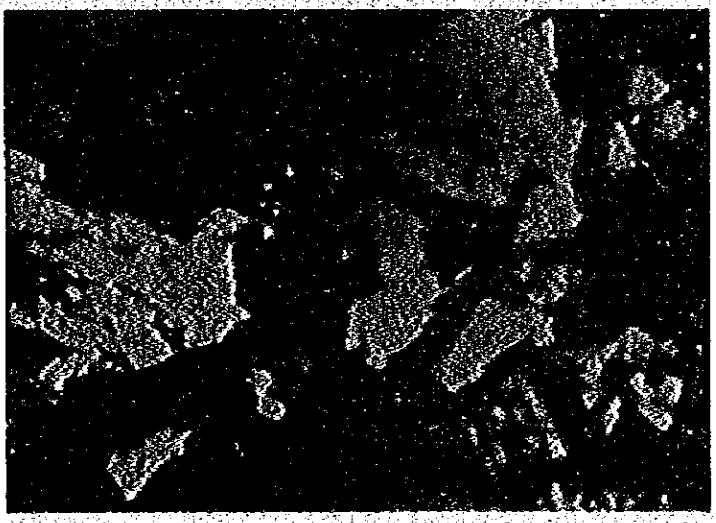
240-B018, 14C,
MD
Metadolerite

x 100

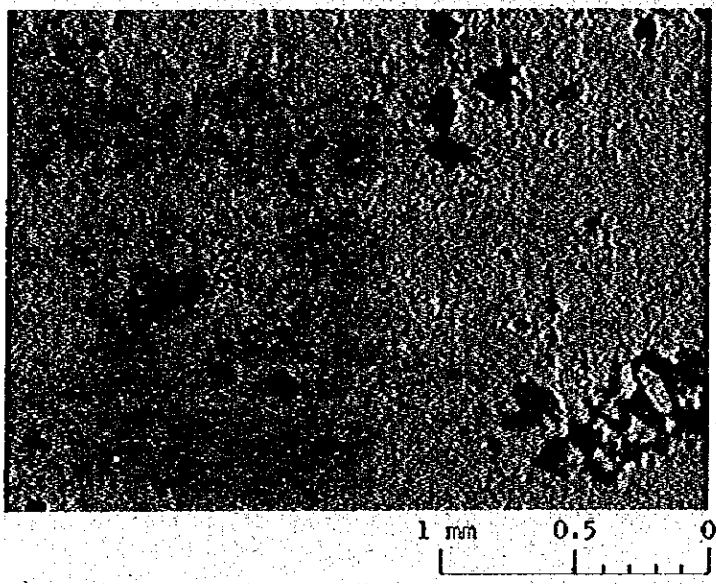
0,5 mm 0

Ophitic texture

Minerals : plagioclase, uralite(actinolite), hornblende, biotite
accessory minerals : chlorite, prehnite, epidote, calcite, apatite, sphene, ilmenite, magnetite, leacoxene, hematite.



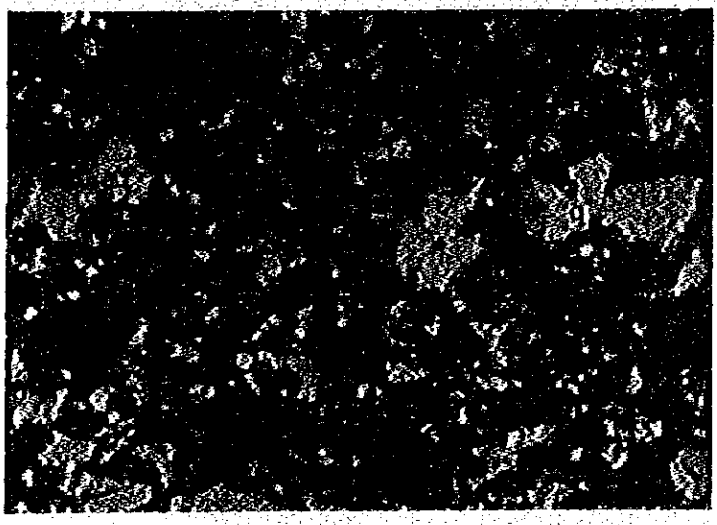
Crossed nicols



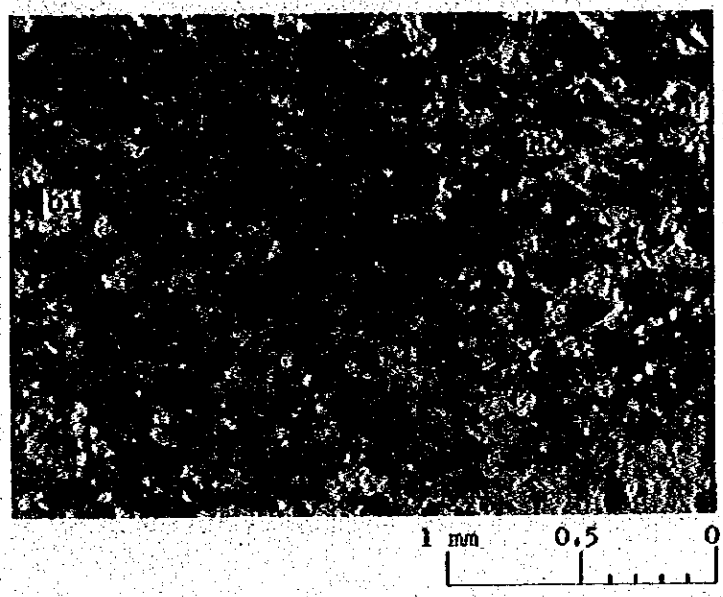
243-B021, 14C
MD
Altered andesite

x 40

Porphyritic texture
Minerals : Quartz, alkali feldspar
accessory minerals : sericite, sphene,
silimanite (?), magnetite



Crossed nicols



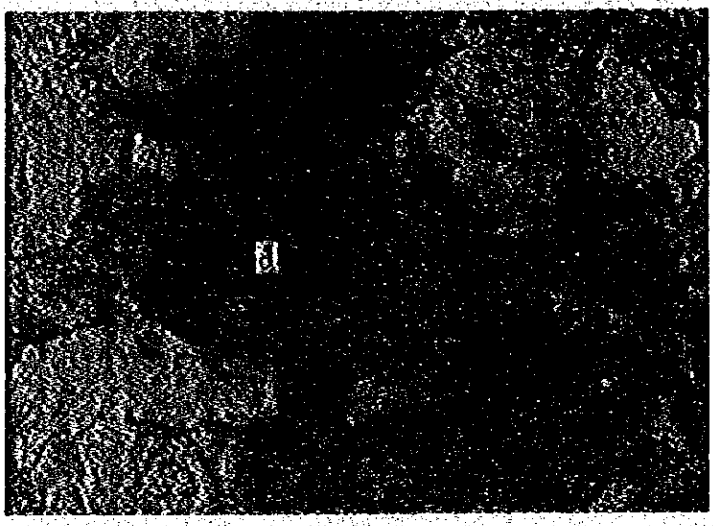
246-B024, 14B,
MD
Porphyrite

x 40

Intersertal texture

Minerals : Plagioclase (andesine)

Accessory minerals : plagiodase (andesine)
hornblende, quartz, biotite, ilmenite, magnetite
Alteration minerals : sericite, chlorite, epidote



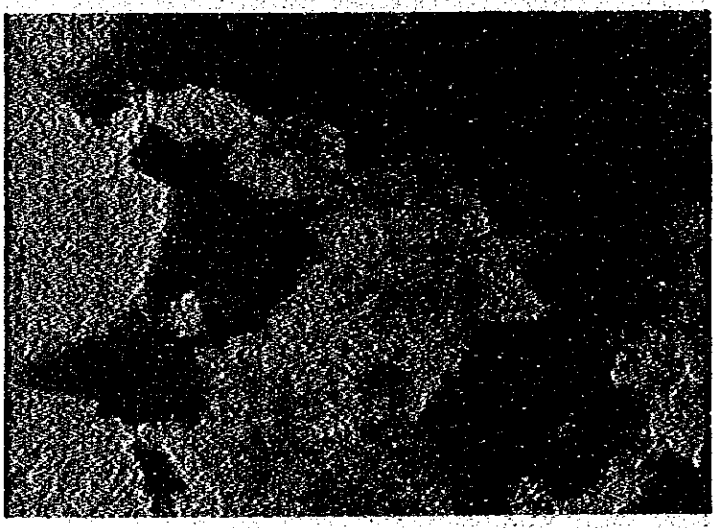
249-B028-1, 16B,
PU
Dolomite

x 100

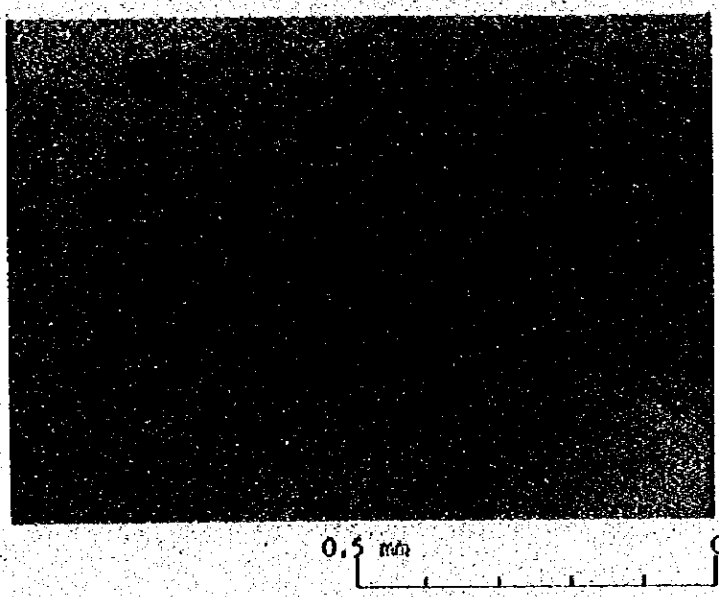
0.5 mm 0

Mosaic texture

Minerals : dolomite



Crossed nicols



251-B029, 14D

VI

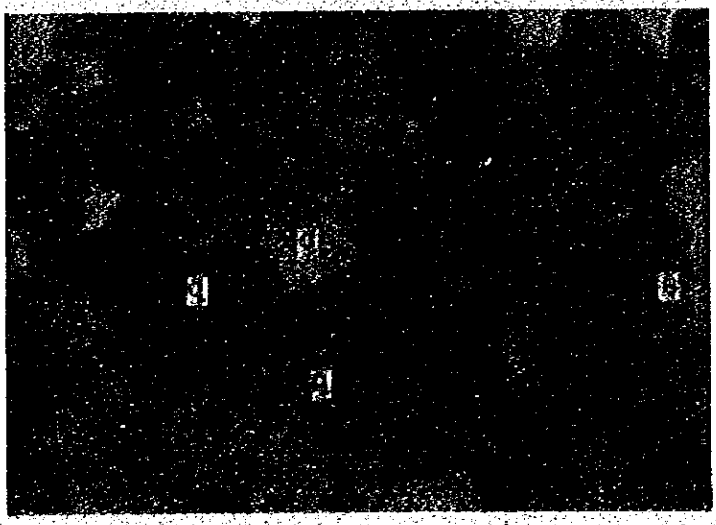
Sandstone

x 100

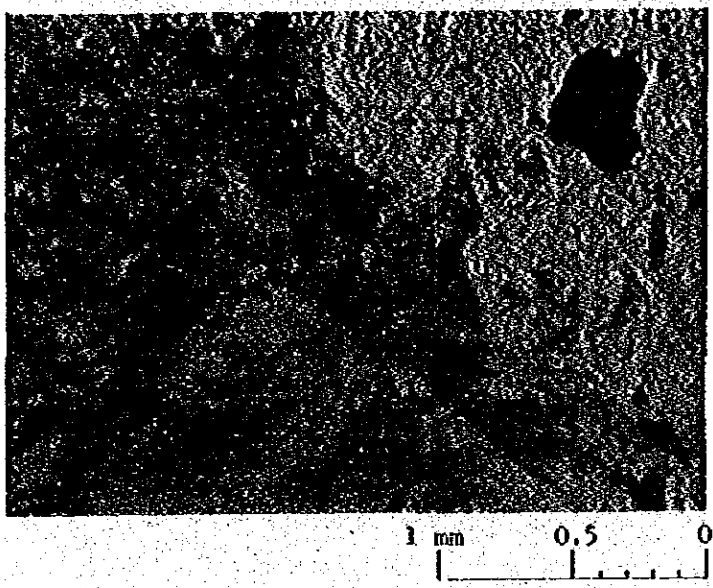
Coarse grained sandstone

Minerals : quartz

Accessory minerals : zircon, sericite.



Crossed nicols



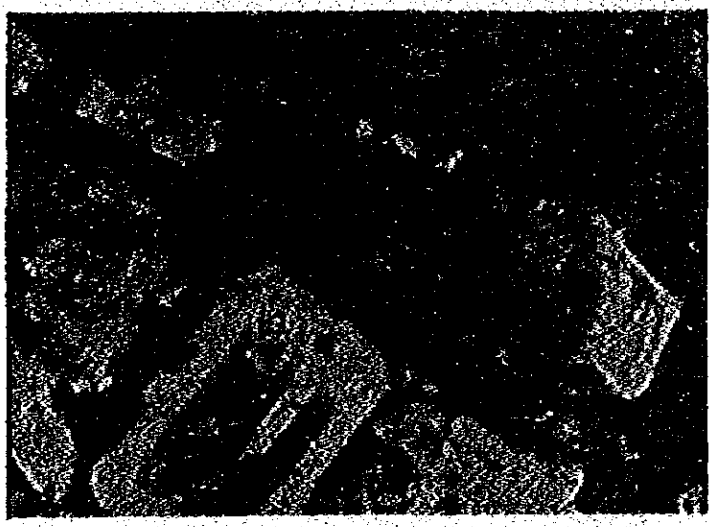
254-C004, 19C,
TM
Altered porphyritic
andesite

x 40

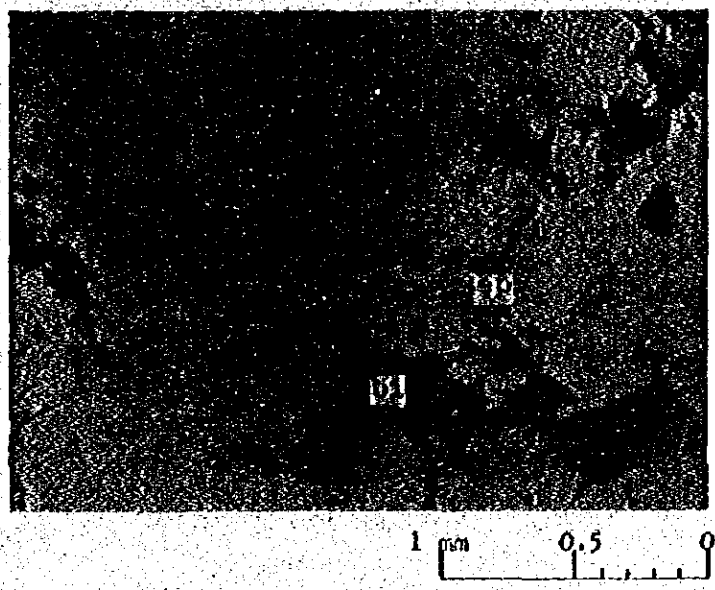
Porphyritic intersertal texture

Minerals : Plagioclase, sanidine

Accessory minerals : microlites of plagioclase, quartz



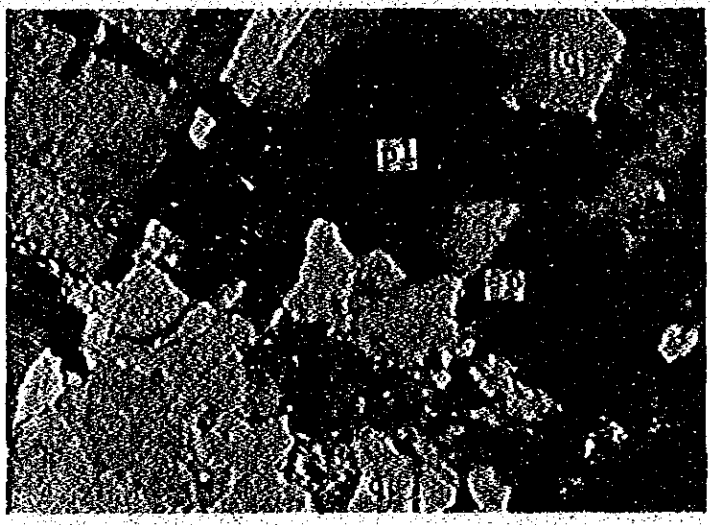
Crossed nicols



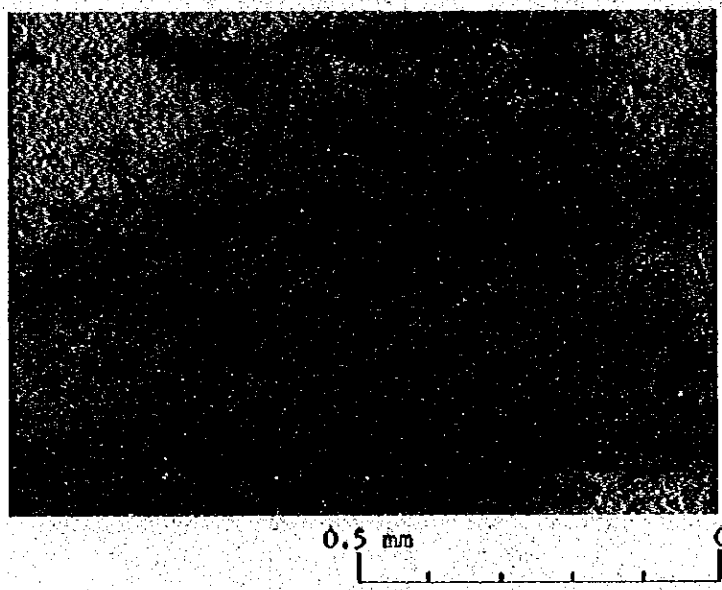
261-C015, 10D,
PG
Biotite granodiorite

x 40

Granular texture
Minerals : Quartz, plagioclase (Oligoclase), biotite
Accessory minerals : sphene,apatite, magnetite
Alteration minerals: chlorite, epidote



Crossed nicols

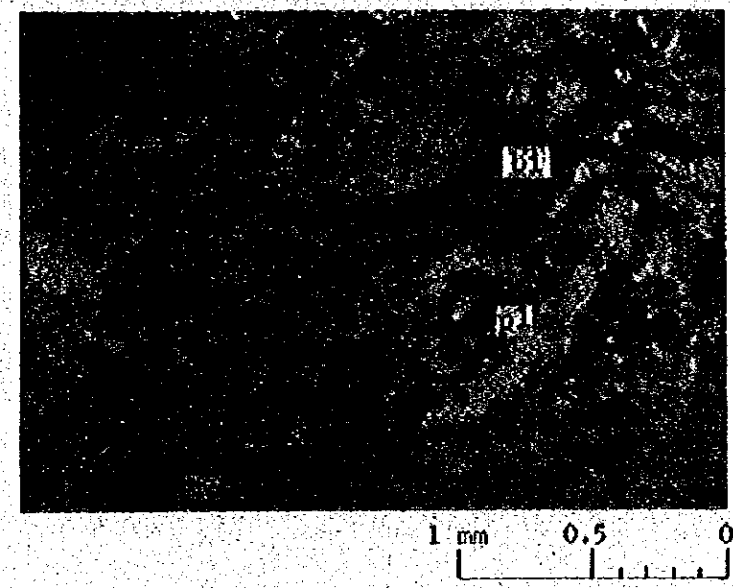


266-C023, 13D
MI
Shale

x 100

Laminated texture with sand stone rock fragments.
Minerals : plagioclase, potash feldspar, quartz.

Crossed nicols



271-C028, 11D,
IO

Biotite hornblende diorite

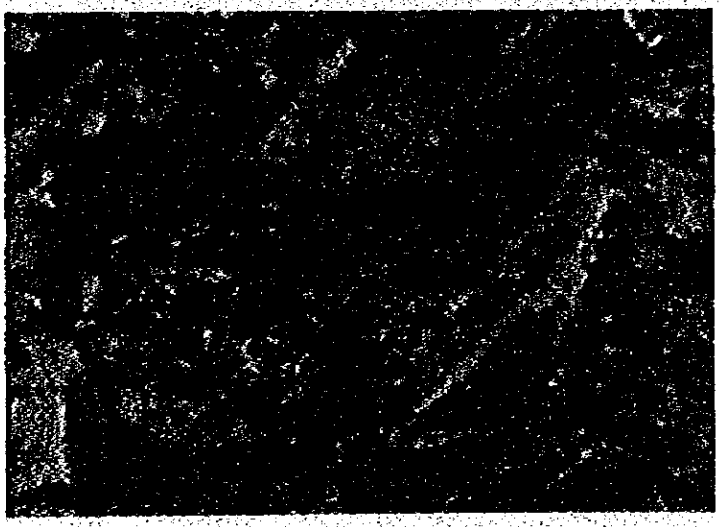
x 40

Equigranular texture

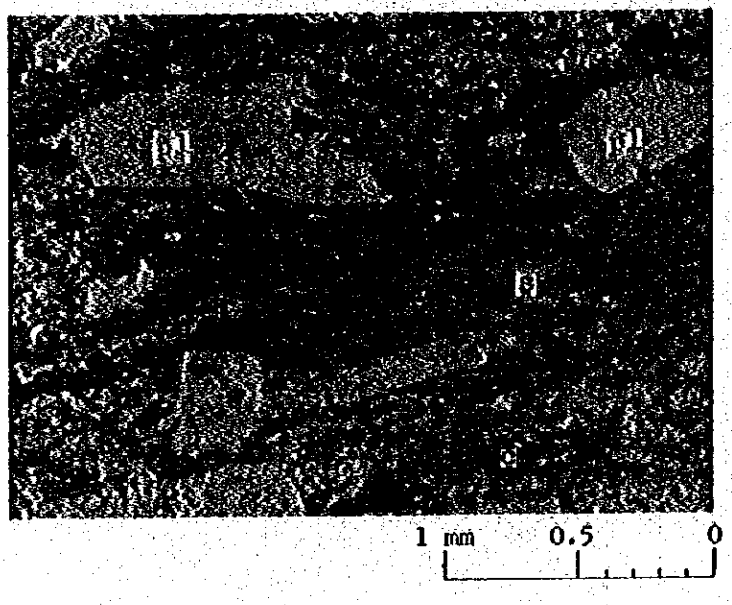
Minerals : Plagioclase, hornblende, biotite

Accessory minerals : Quartz, potash-feldspar, apatite, magnetite

Alteration minerals: Chlorite, epidote, calcite



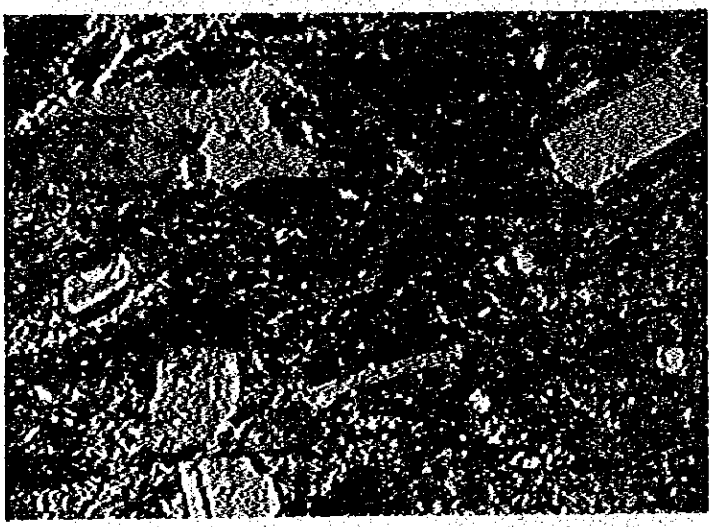
Crossed nicols



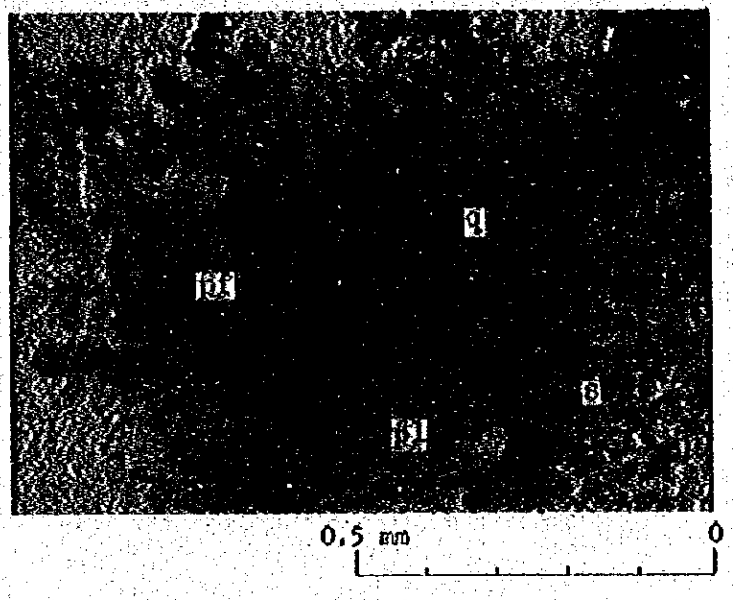
273-C030, 12D,
MI
Dacitic welded tuff

× 40

Welded texture
Accessory minerals : Quartz, apatite
Alteration minerals: Epidote, chlorite, calcite, sericite



Crossed nicols

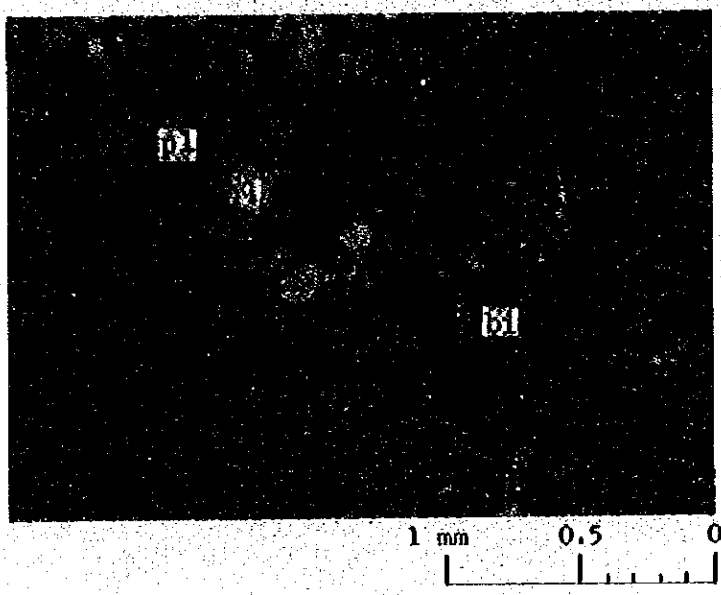


283-A010, 14B
MI
Conglomerate

x 100

Minerals : (Volcanic rock fragments), Plagioclase, Quartz, potsh feldspar
Accessory minerals : Opaque minerals
Alteration mineral : Sericite

Crossed nicols



287-A016, 14B,

PG

Biotite hornblende diorite

x 40

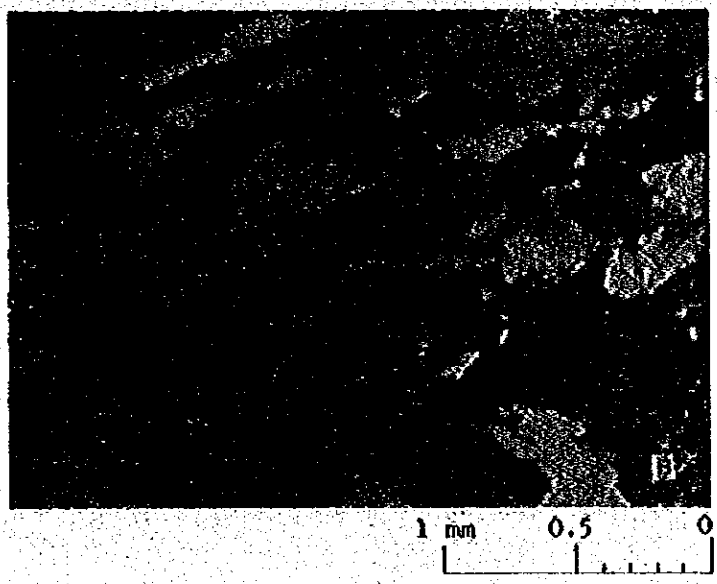
Equigranular texture

Minerals : Plagioclase, hornblende, biotite, ore mineral

Accessory minerals : Apatite, quartz

Alteration minerals: Epidote, chlorite, sericite

Crossed nicols



288-A017, 14B,

PO

Garnet-biotite-muscovite gneiss

x 40

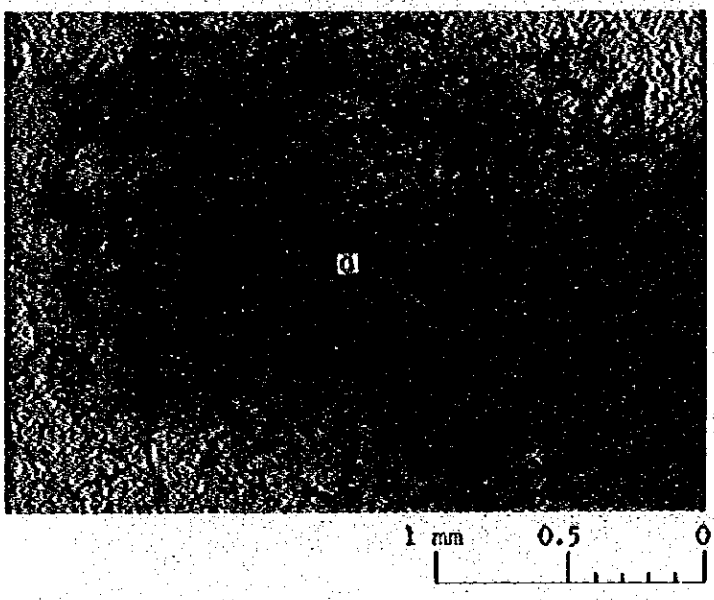
Crossed nicols

Lepidoblastic texture

Minerals : Quartz, plagioclase (Albite), potash feldspar

Accessory minerals : Garnet, biotite, epidote, zricon. sphene, calcite, apatite, ilmenite, hematite

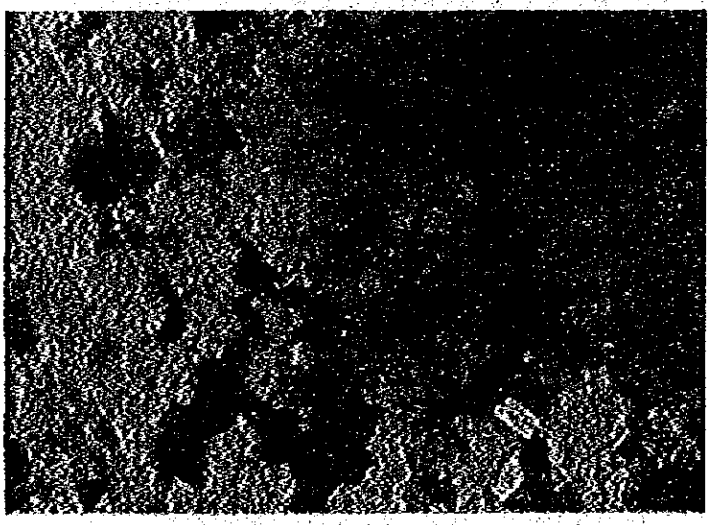
Alteration minerals: Sericite, chlorite



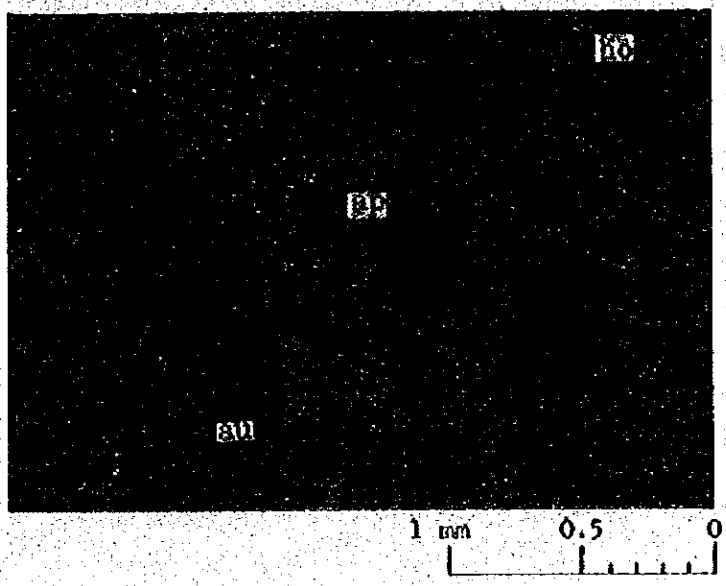
294-A025, 14C,
PU
Limestone

x 40

Sparitic texture
Calcite
Accessory mineral : Quartz



Crossed nicols



301-A037, 19B,
TM

Soda-augite hornblende monzonite

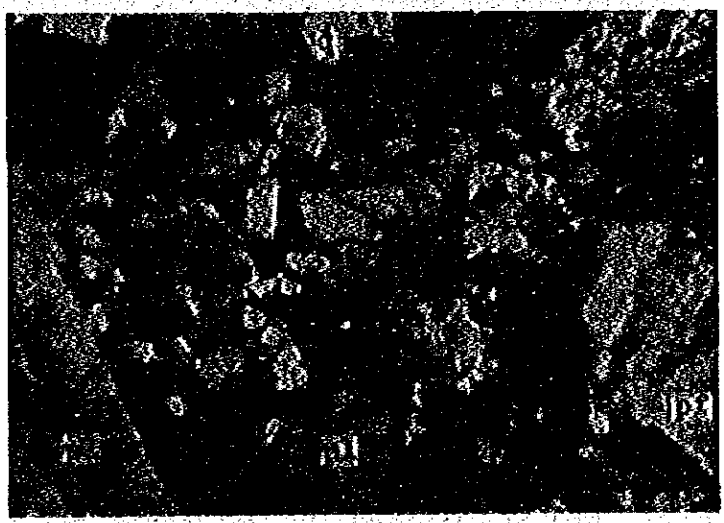
x 40

Porphyrytic and protoclastic texture

Minerals: Plagioclase, myrmekite, potash-feldspar, quartz, hornblende, soda-augite, biotite

Accessory minerals : Sphene, apatite, magnetite

Alteration minerals: Sericite



Crossed nicols

309-D029, 17C,

CH

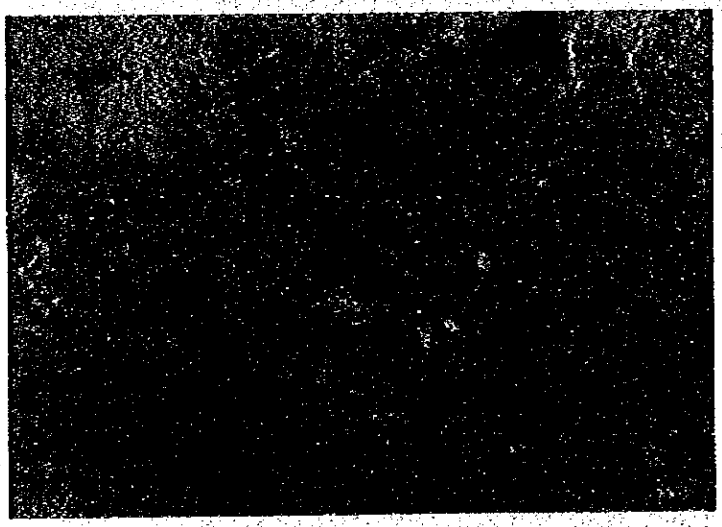
Limestone

x 100

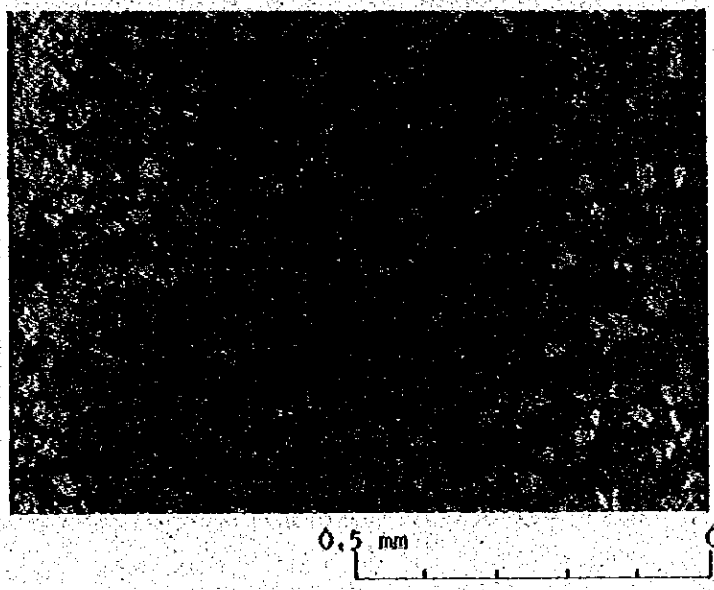
0.5 mm 0

Microcrystalline texture

Minerals : Sparite, Quartz, Fossils (foraminiferas, Calcareous algae)



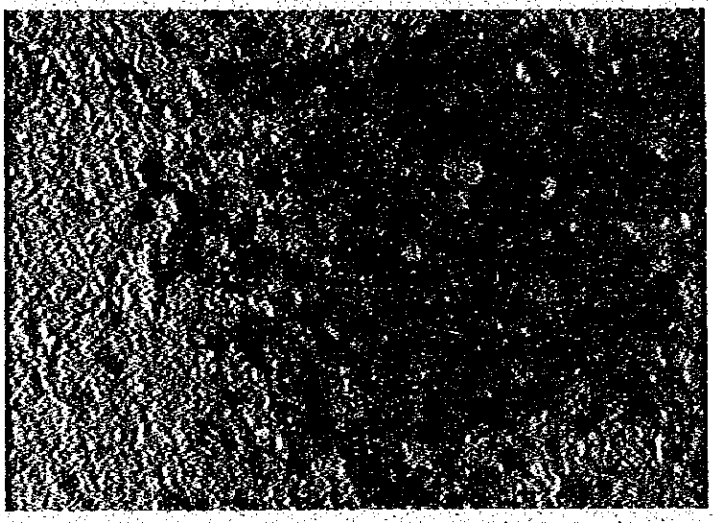
Crossed nicols



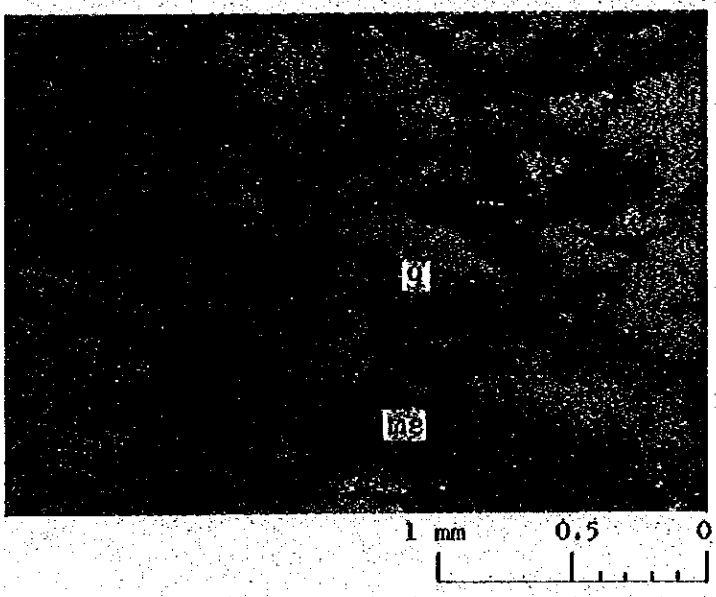
312-D045, 13E,
CH
Limestone

x 100

Microcrystalline mozaic texture
Minerals : Quartz, potash - feldspar, piagioclase



Crossed nicols



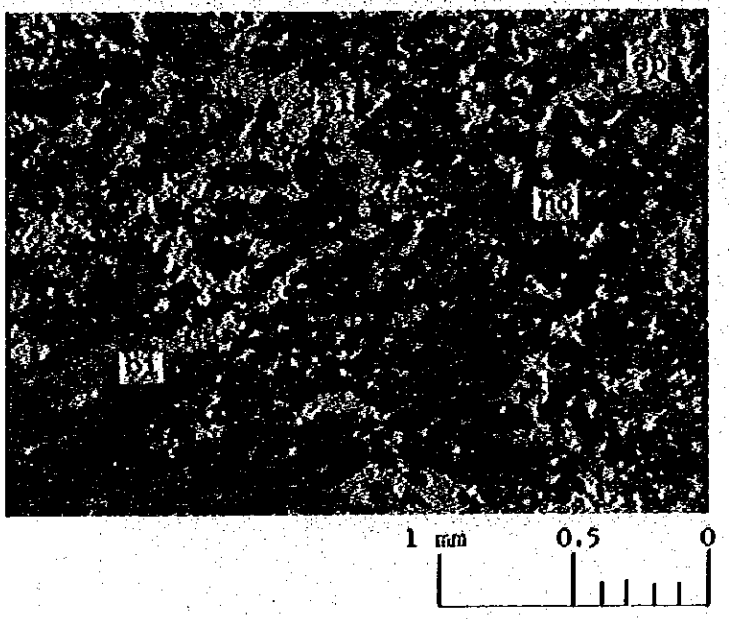
313-D058, 13B,
BC
Quartz schist

x 40

Lepidoblastic texture

Minerals : Quartz, muscovite, clay minerals

Accessory minerals : Feldspars, opaque minerals, zircon, sphene



318-D065, 13B,
BC
Epidote amphibolite

Fine grained granular texture

Shistosity is not distinct

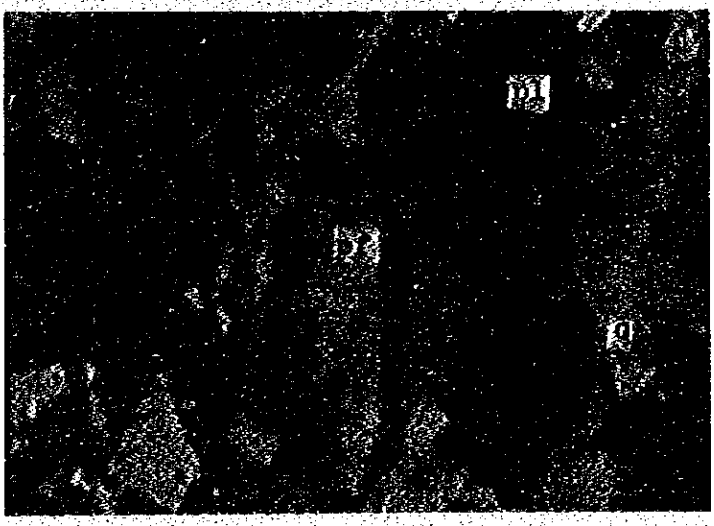
Minerals : Green hornblende, sodic plagioclase, epidote

Accessory minerals : biotite, sericite

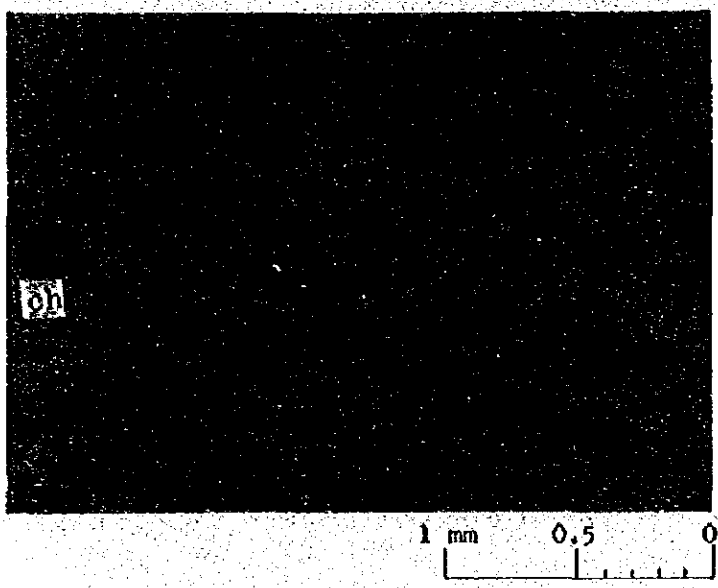
320-D069, 13B,
PG
Sheared biotite granodiorite

x 40

Porphyritic, protoclastic, partly cataclastic texture
Minerals : Quartz, plagioclase, potash feldspar, biotite
Accessory minerals : Calcite, sphene
Alteration minerals: Sericite, chlorite



Crossed nicols



324-D079, 13C,

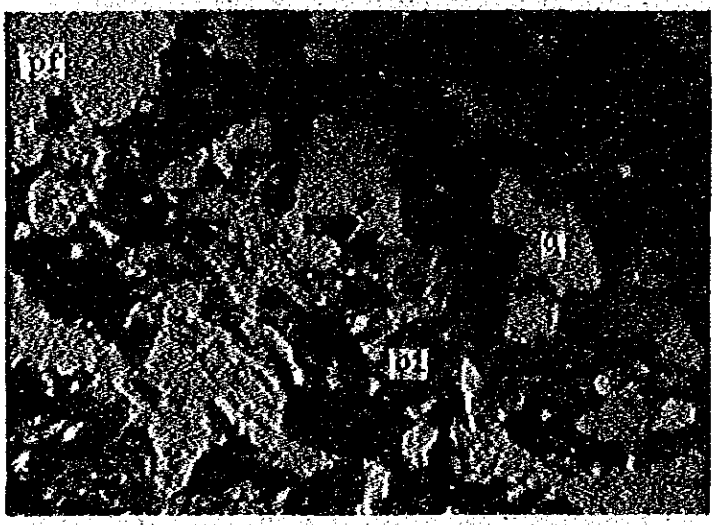
MD

Muscovite-bearing biotite micro-adamellite

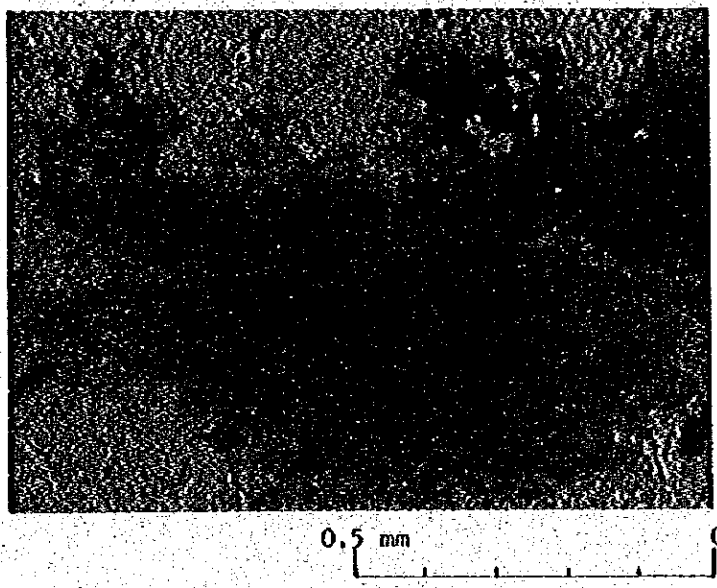
x 40

Minerals : Plagioclase, quartz, potash feldspar, biotite

Alteration minerals : Sericite, chlorite, epidote



Crossed nicols



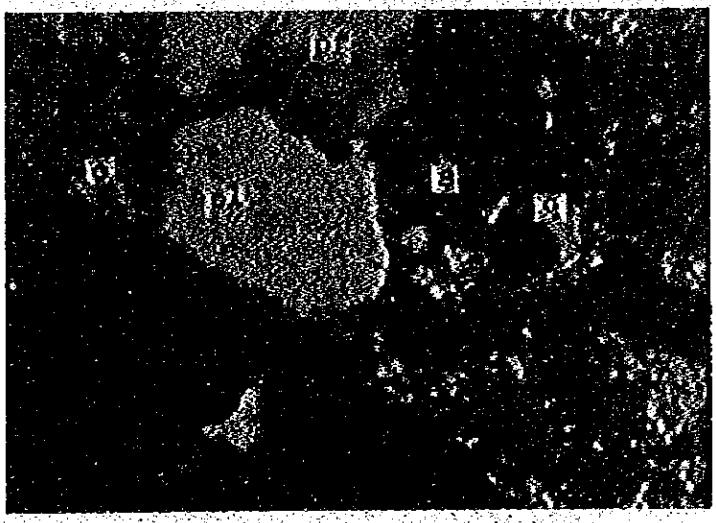
329-D089, 13D
MI
Sandstone

x 100

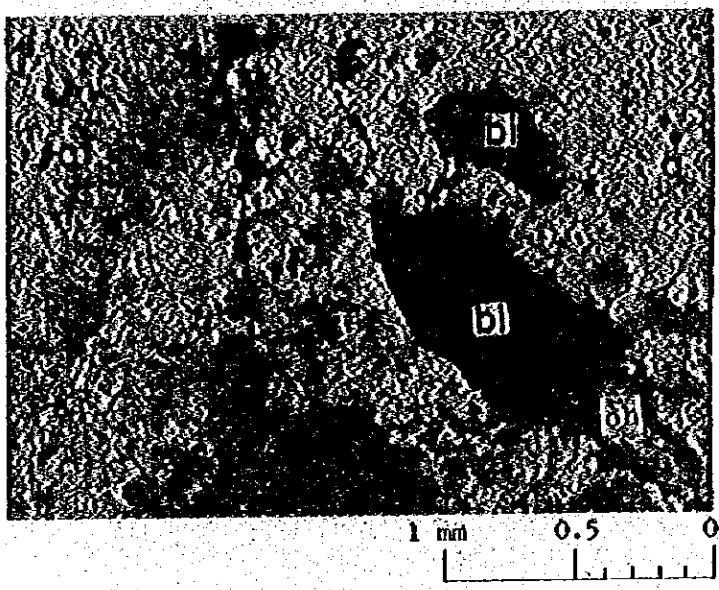
Coarse grained texture

Minerals : Quartz, Potash feldspar, Plagioclase, cherty rock fragment.

Alteralion minerals : sericite, Calcite



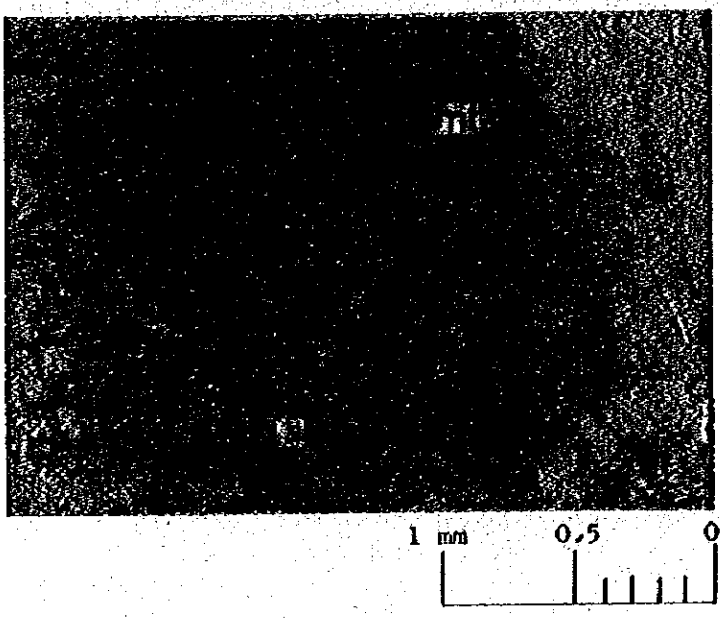
Crossed nicols



341-RE001, 6,
MP
Biotite granite

x 40

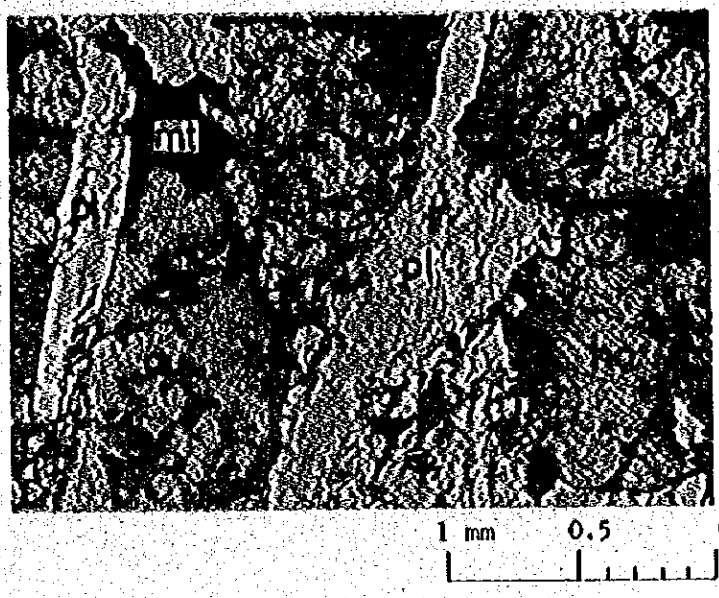
Equigranular texture
Minerals : Plagioclase, potash feldspar, quartz, biotite
Accessory minerals : Iron ore
Alteration minerals: Chlorite



342-RE002, 6,
MP
Sandstone hornfels

x 40

Coarse to very coarse grained quartzose sandstone
Minerals : Quartz
Alteration minerals : Sericite

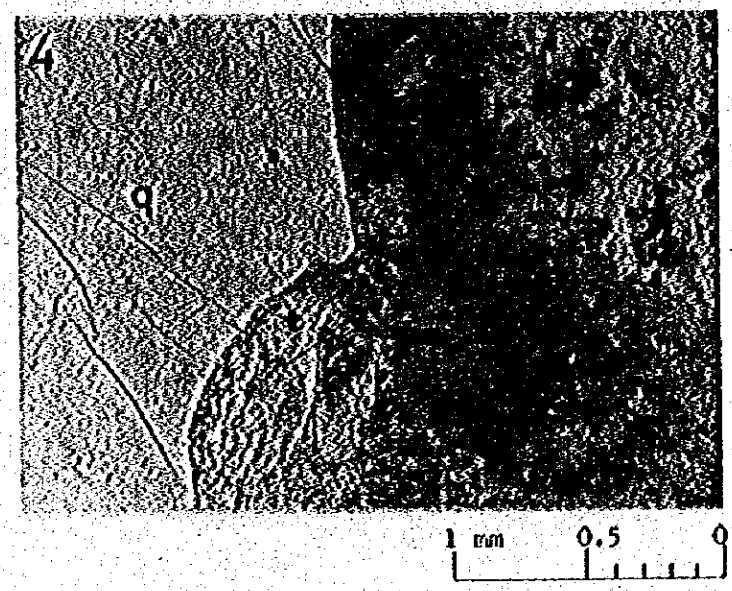


344-RE012, 10,
CG
Hornblende augite gabbro

x 40

Hypidiomorphic texture

Minerals : Plagioclase, Augite, Hornblende, Magnetite



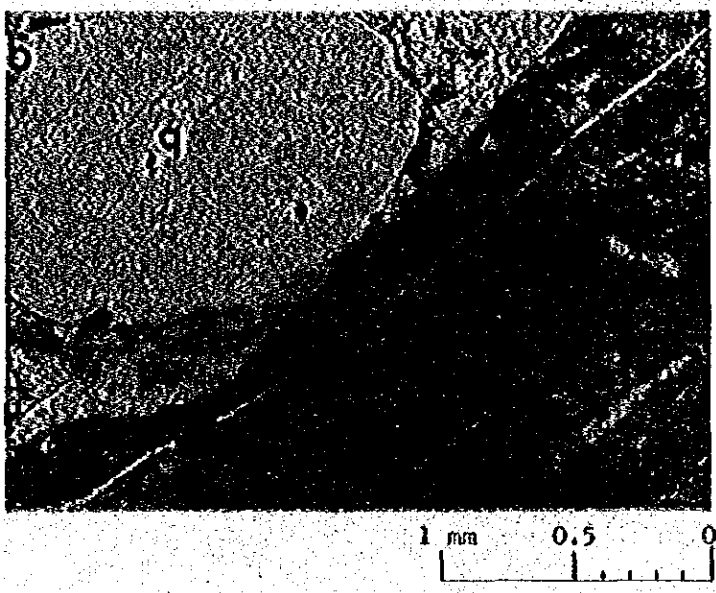
368 - RF019, 4
TV
Biotite quartz porphyry

x 40

Porphyritic texture

Minerals : Quartz, plagioclase

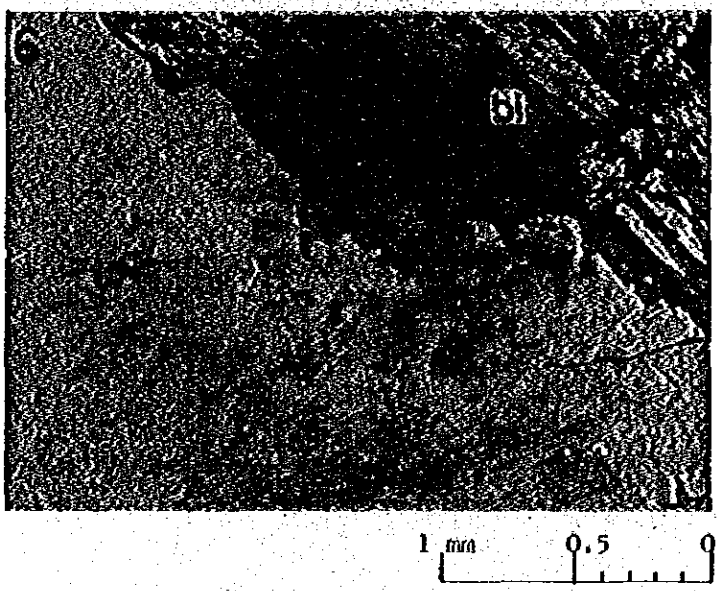
Alteration minerals : Kaoline, Sericite



454-RG009, 4,
MD
Tuff

x 40

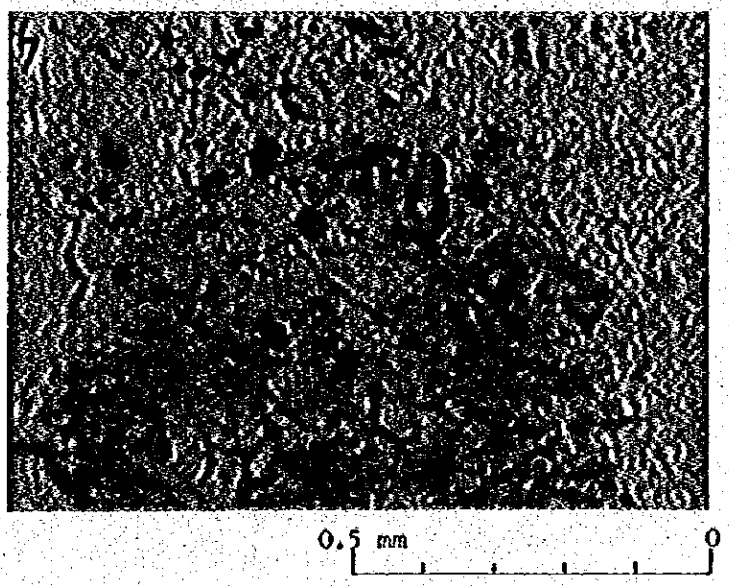
Tiny fluidal texture
Minerals : Quartz, Plagioclase,(Pumice, Volcanic ash)



462 - RG087, 13
CG
Biotite granite

x 40

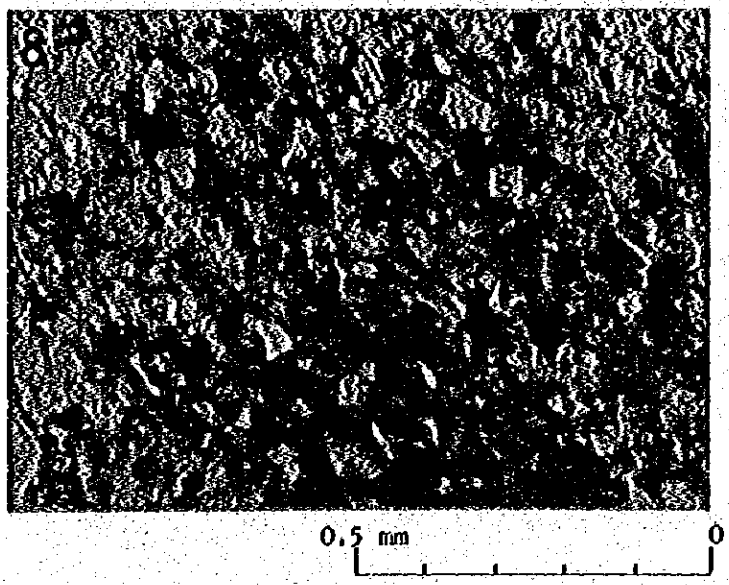
Granular texture
Minerals : Quartz, Alkali feldospar, Biotite
Accessory mineral : Sphene
Alteration minerals : Chlorite, Clay mineral,
Sericite



466-RG106, 14,
PU
Silicified rock

x 100

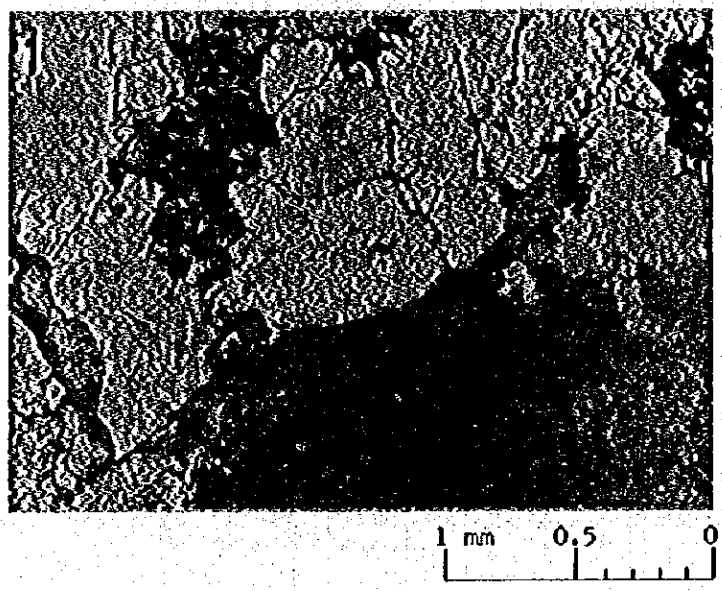
Alteration minerals : Quartz, Sericite, Clay mineral,



469 - RG118, 16
PU
Tuff

x 100

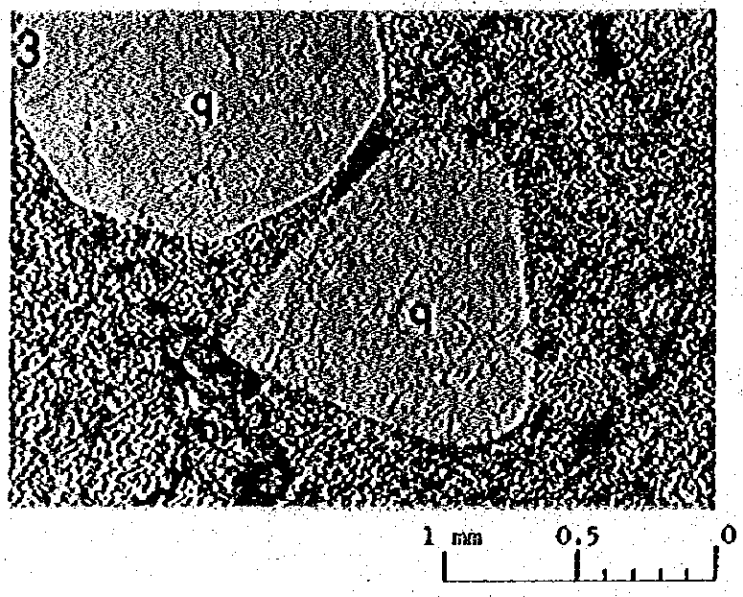
Minerals : Quartz, (Volcanic ash, Glass)
Alteration mineral : sericite



496-RH001, 7,
PU
Silicified conglomeratic limestone

x 40

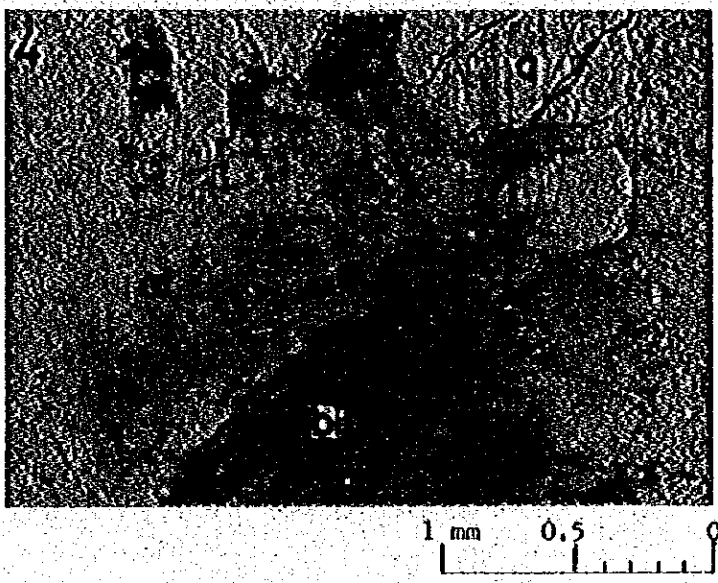
Conglomeratic coarsely crystallized limestone (upper) is partly replaced by microquartz (lower).



498 - RH019, 8
MP
Biotite quartz porphyry

x 40

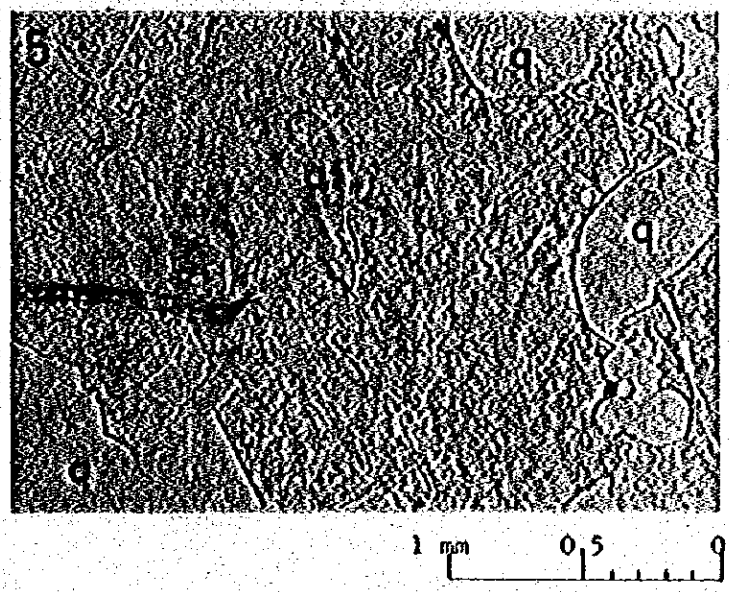
Porphyrytic texture
Quartz is partly corroded and contains gas cavity.
Alkali feldspar is almost altered to sericite and clay minerals.



501-RH030A, 10,
CG
Biotite granite

x 40

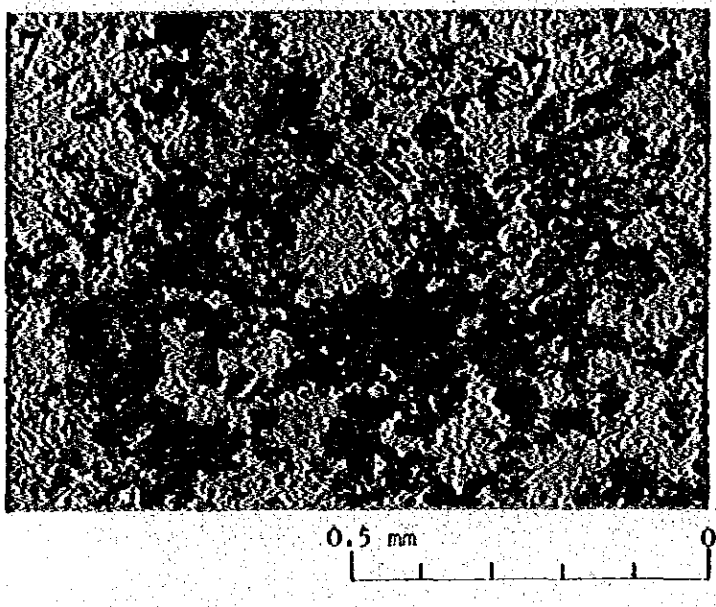
Granular texture
Minerals : Quartz, Alkali-feldspar, Plagioclase, Biotite
Alteration minerals : Kaolinite, Sericite
Black magnetite



502 - RH030B, 10
CG
Micro muscovite granite

x 40

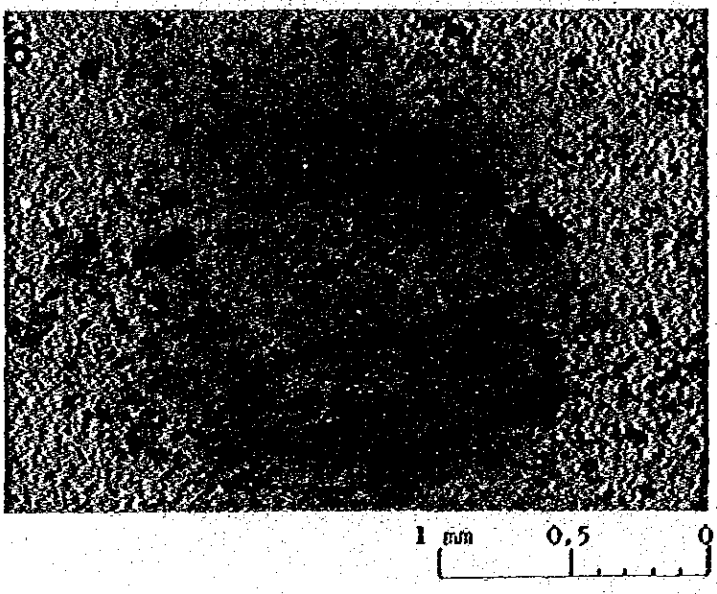
Granular texture
Minerals : Qartz, Alkali-feldspar, Plagioclase, Muscovite
Alteration minerals : Chlorite, Sericite,
Clay minerals, Limonite



503-011038, 12,
PU
Silicified rock

x 100

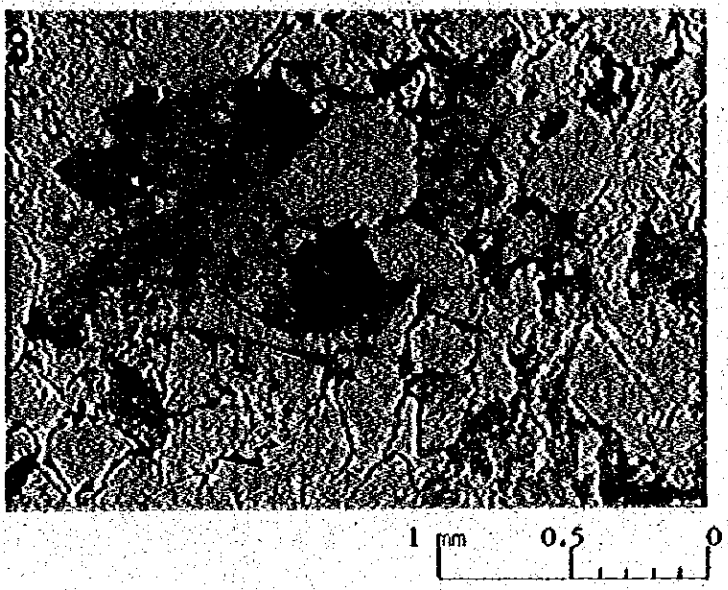
The original rock is andesitic tuff.
Volcanic fragment : Pyroxene, calcite, very fine substances (quartz, plagioclase, volcanic glass, black iron ore).



505 - RH040, 12
TM
Hornblende porphyrite

x 40

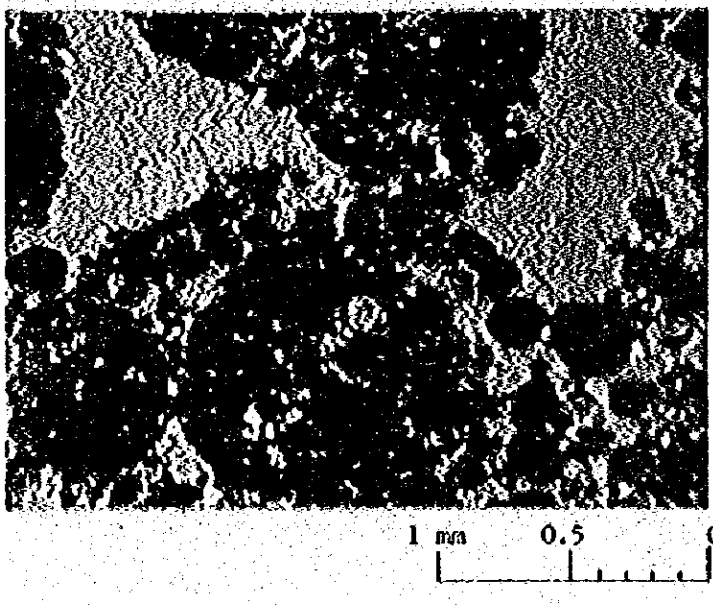
Porphyritic texture
Minerals : Plagioclase, Hornblende (plegioclare alteres to clay minerals perfectly)



506-RII050, 18,
MI
Arkose sandstone

x 40

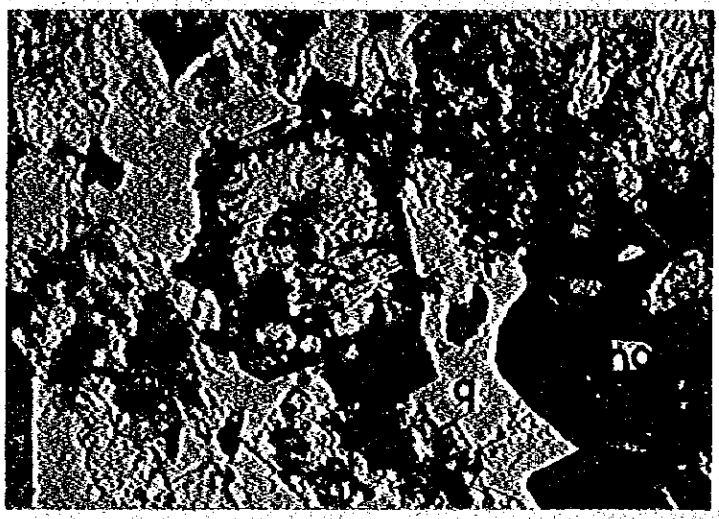
Quartz (clear) and feldspar (clouded) grains are cemented by silty matrix.



568 - RI005, 4
OR
Pelsparite

x 40

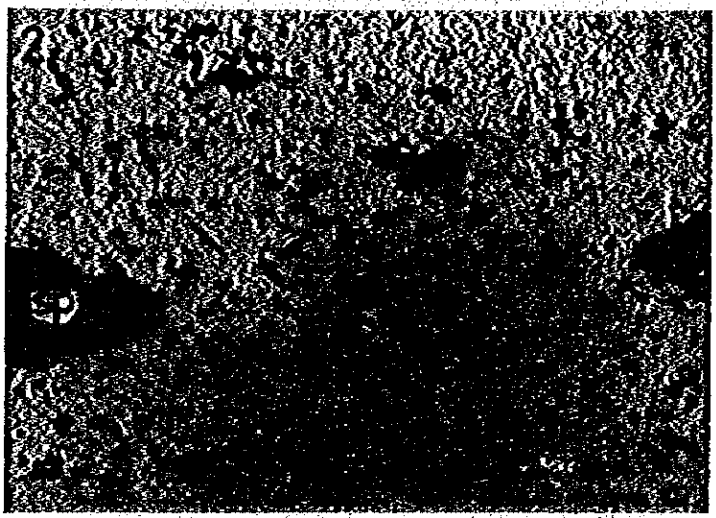
Various size of pellets (dark) in sparry calcite (clear) matrix.



580-RI086, 19,
MD
Quartz augite hornblende diorite

x 40

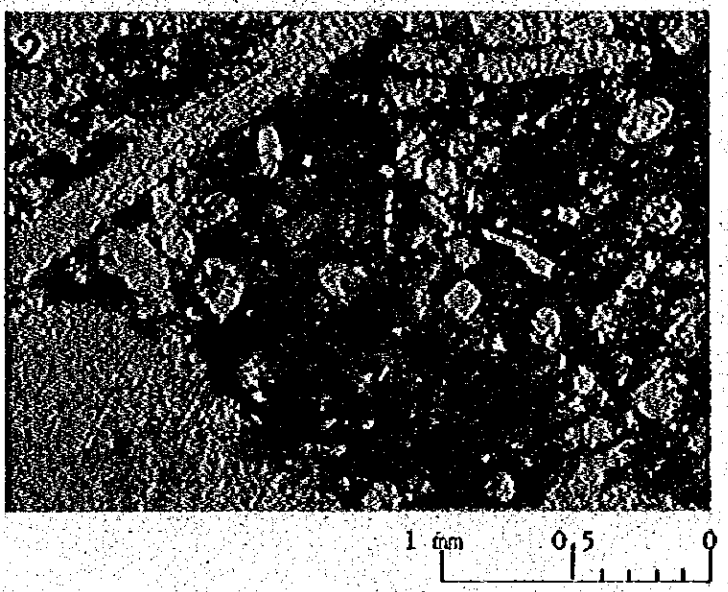
Hypidiomorphic texture
Minerals : Quartz, Plagioclase (Andesine), Hornblende, Augite
Accessory minerals : Magnetite, Apatite
Alteration minerals : Kaolinite, Sericite.



586 - RI103, 15
CH
Biotite hornblende porphyrite

x 40

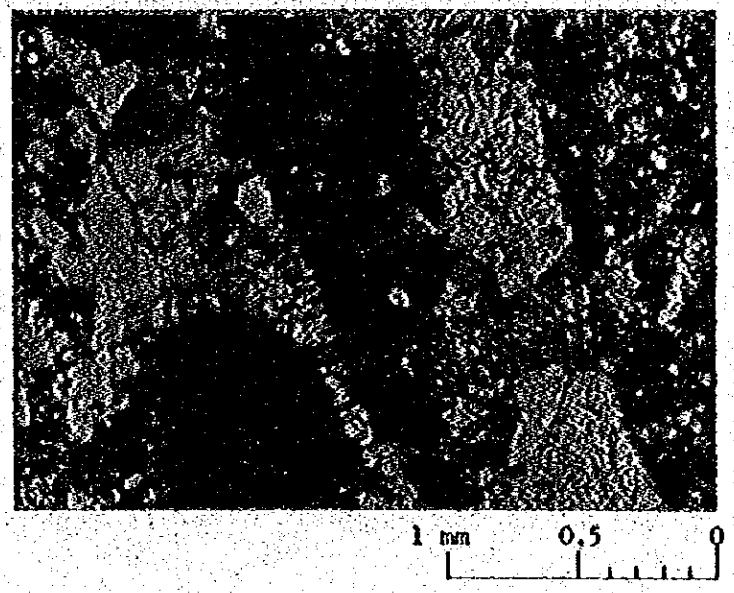
Porphyritic texture
Minerals : Plagioclase, Biotite, Hornblende
Accessory minerals : Sphene, Ilmenite, Magnetite
Alteration mineral : Sericite



588-RI122, 15,
PU
Echinoidal biomicrite

x 40

Spines (cylindrical form) and plate (left lower corner) of echinoid are cemented with micrite.



592 - RI141, 19
PU
Conglomeratic limestone

x 40

Angular and rounded comicrite (center), and radiolarian biomicrite (left and right sides) of intraclasts are cemented by coarsely crystallized sparry calcite.

Fig. 12-1 Photomicrographs of Pb-ore I

A: (349, OE 287)

Galena (white) is closely associated with bladed shaped gangue minerals (dark gray).

B: (394, OE 287)

Same as A, white granular grains are pyrite.

C: (351, OE 289)

Irregular shaped galena mass.

D: (351, OE 289)

Galena is replaced by fine nonopaque mineral (dark gray, cerrussite?), showing "dusty" texture.

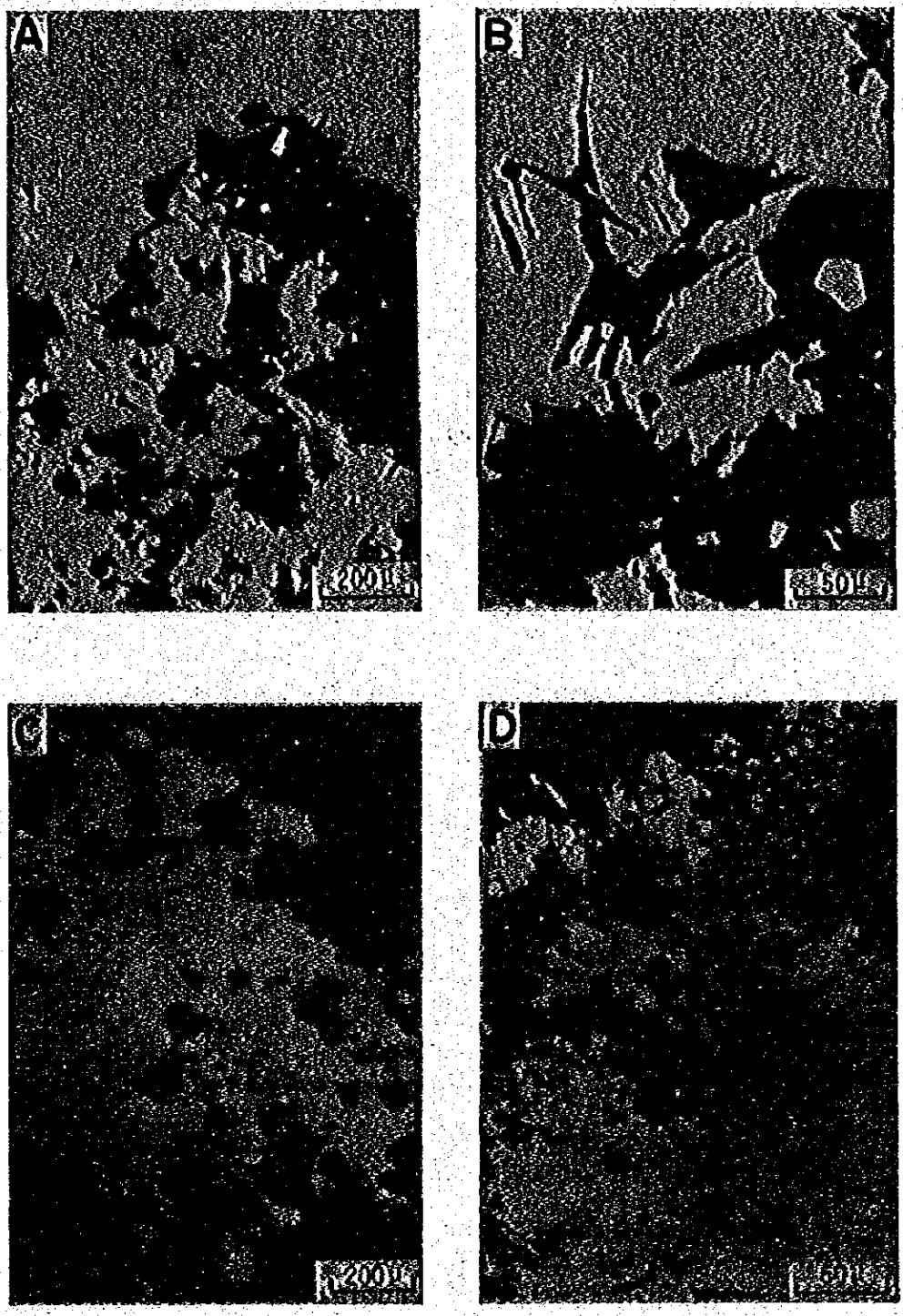

A
B
C
D

Fig. 12-2 Photomicrographs of Pb-ore II

A: (366, OP 017)

Galena (white) and aggregates of fine grains of pyrite (white, granular shaped).

B: (366, OP 017)

Galena (white) is filling interstital among euhedral crystals of gangue minerals (dark gray).

C: (397, OP 073)

Deformed texture in galena.

D: (457, OG 027)

Galena (white) and sphalerite (light gray) veinlets cut-across gangue minerals (dark gray, rough).

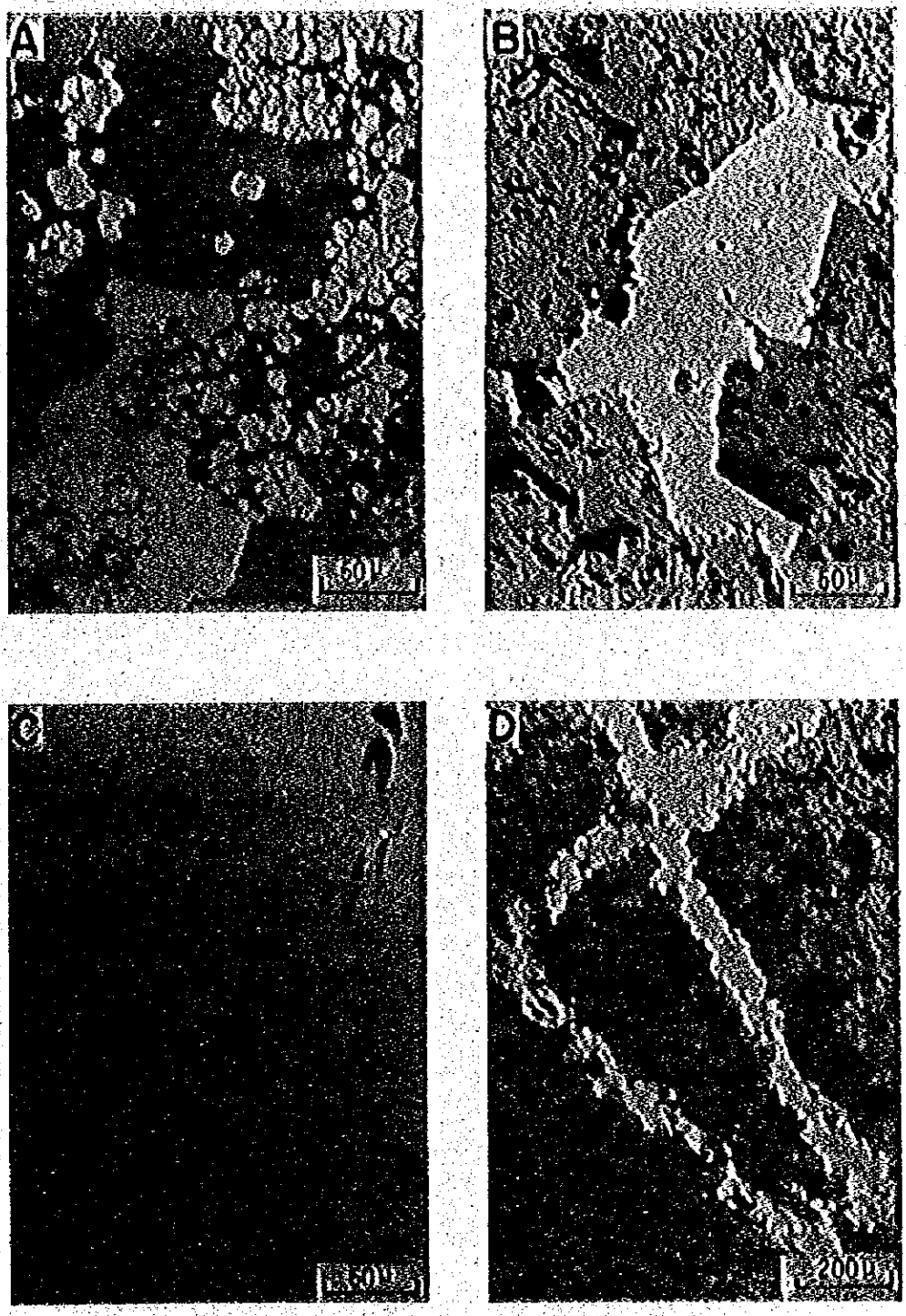

A
60μ
B
60μ
C
50μ
D
200μ

Fig. 12-3 Photomicrographs of Zn-ore I

A: (384, OP 053)

Sphalerite (white).

B: (384, OP 053)

Galena (white) replaced by smithsonite (pale gray).

C: (388, OP 057)

Original galena crystals are replaced by smithsonite (pale gray), true gangue (darker).

D: (384, OP 053)

Fine replacement texture galena (white) and smithsonite (light gray).

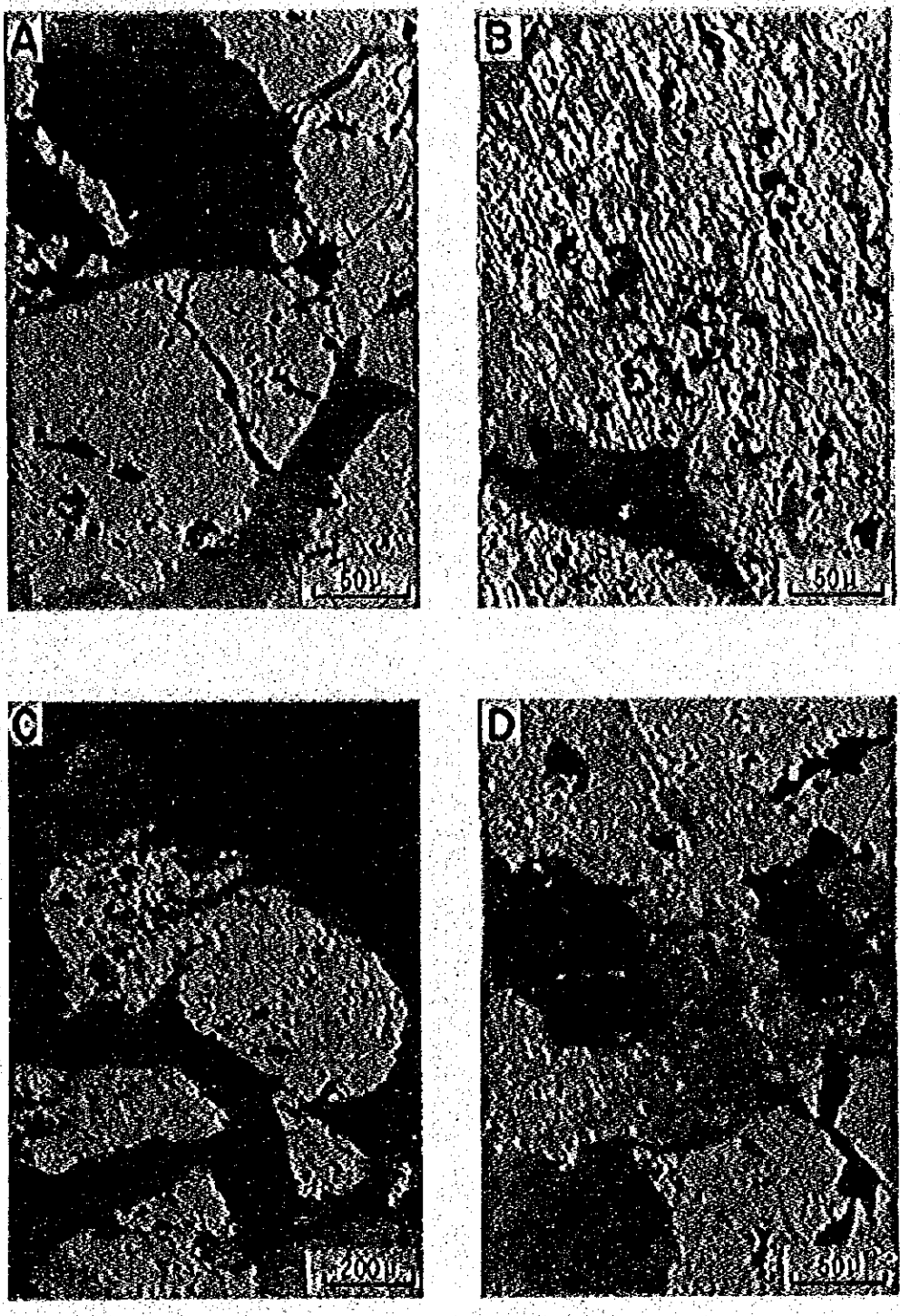

A
50μ
B
50μ
C
200μ
D
50μ

Fig. 12-4 Photomicrographs of Zn-ore II

A: (393, OF 064)

Galena (light gray).

B: (393, OF 064)

Tiny spherical pyrite crystals (white) concentrate in gangue veinlet (dark gray) among sphalerite (light gray).

C: (393, OF 064)

Tiny pyrite (white) rims sphalerite (light gray).

D: (393, OF 064)

Radial aggregate crystal of pyrite (white) replaced by goethite (gray).

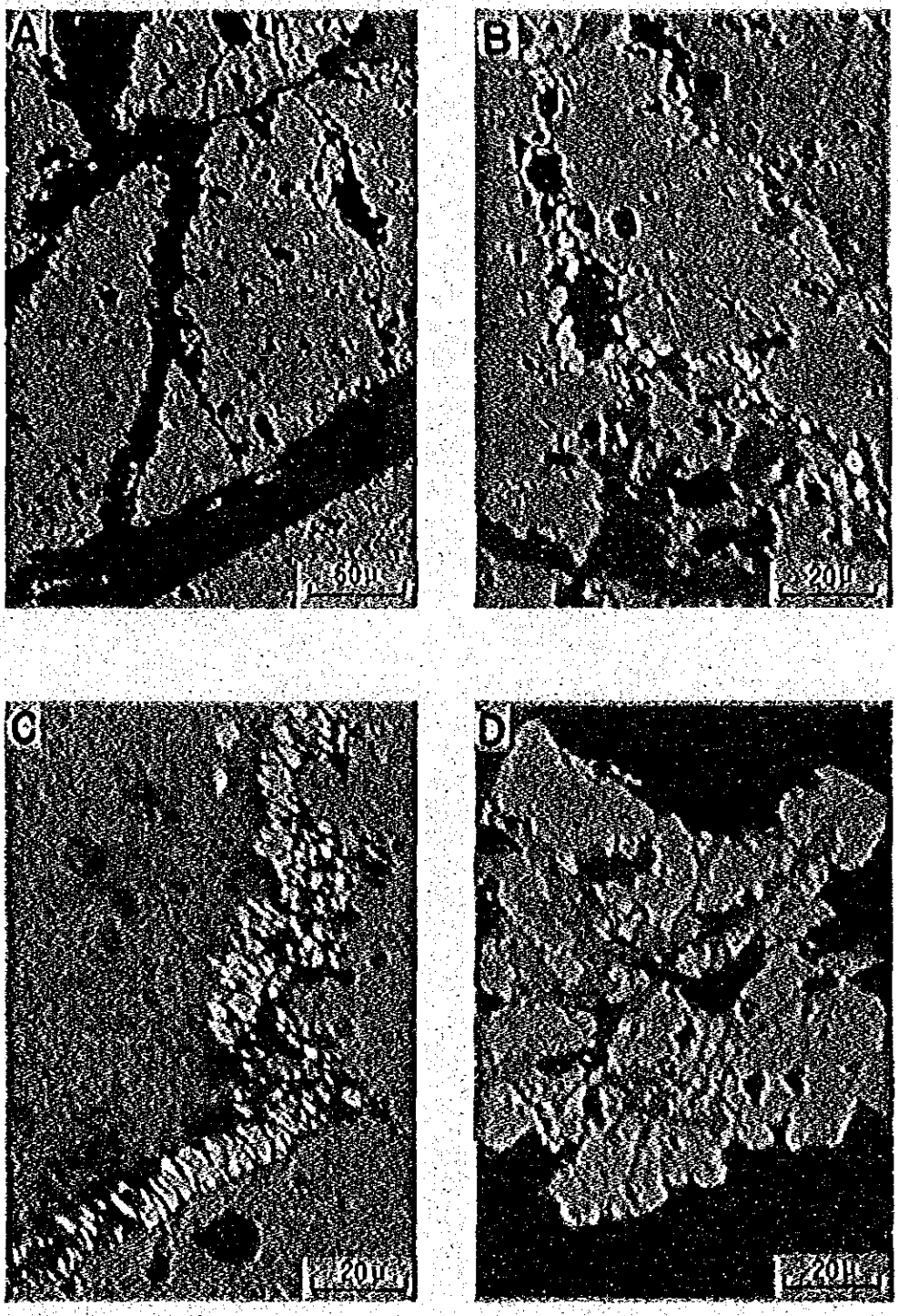

A
60μ
B
20μ
C
20μ
D
20μ

Fig. 12-5 Photomicrographs of Zn-ore III

A: (461, OG 079)

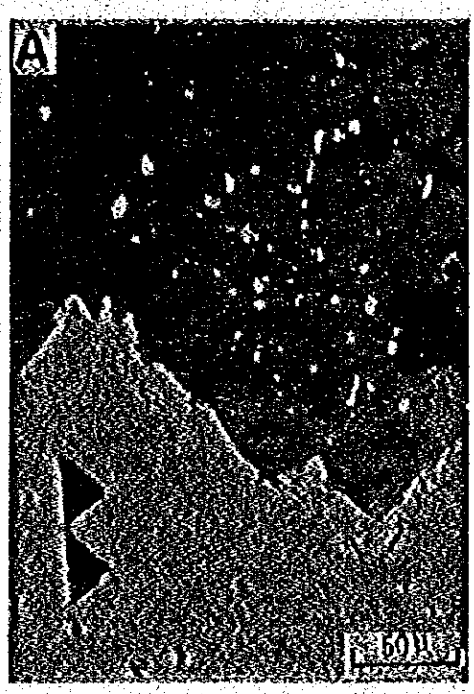
Sphalerite (dark gray) with exsolved chalcopyrite (light gray) is coexisting with galena (white).

B: (461, OG 079)

Sphalerite with chalcopyrite dods coexisting with idiomorphic arsenopyrite (white).

C: (461, OG 079)

Idiomorphic crystal of arsenopyrite contacts with sphalerite (light gray).


A
50μm


B
50μm

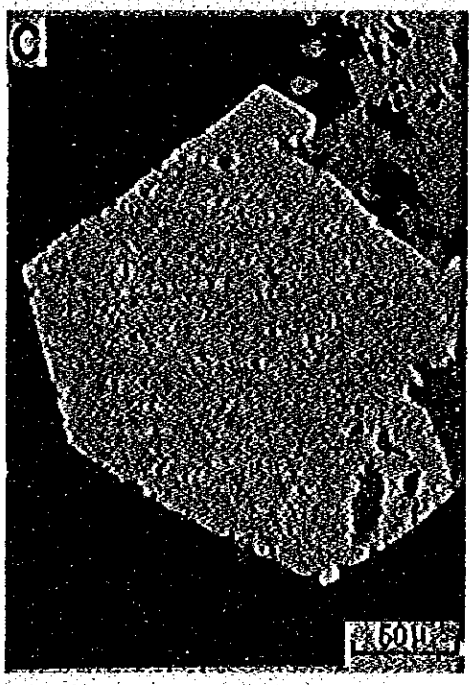

C
50μm

Fig. 12-6 Photomicrographs of Cu-ore I

A: (293, A 024)

Irregular shaped tennantite mass (white).

B: (293, A 024)

Arsenopyrite crystal (white) is contained in tennantite (light gray) which is replaced by chalcocite and covellite (dark gray) at rim.

C: (579, OI 082)

Radial aggragate crystals of pyrite (white) replaced by goethite (gray).

D: (293, A 024)

Idiomorphic hexagonal crystal of arsenopyrite.

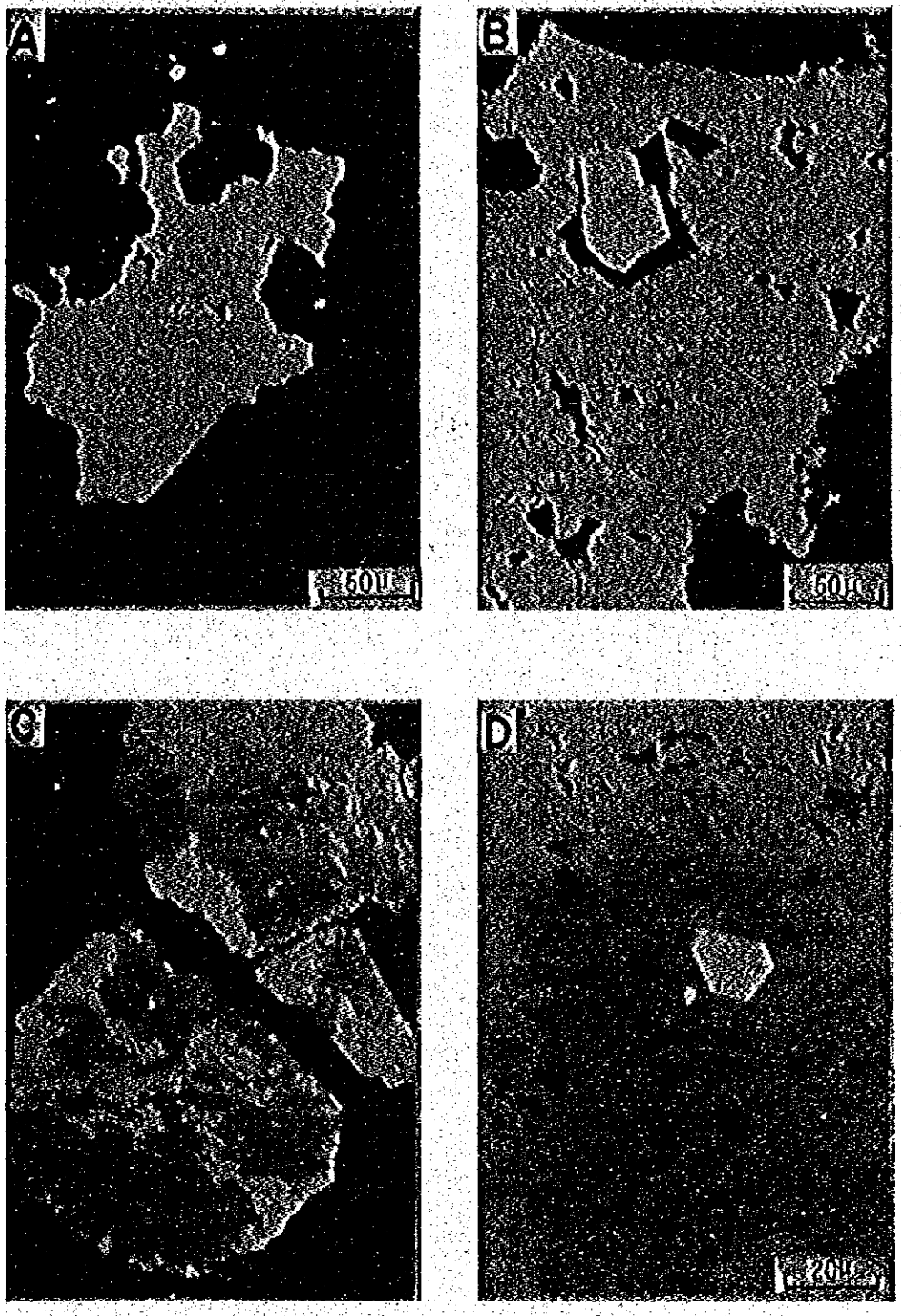

A
B
C
D

Fig. 12-7 Photomicrographs of Cu-ore II

A: (350, 0E 288)

Tennantite (light gray) contains tiny chalcopyrite blebs (white) and replaced by thin covellite veinlet (gray).

B: (350, 0E 288)

Tennantite (light gray) coexisting with chalcopyrite (white).

C: (350, 0E 288)

Chalcopyrite (white)grain replaced by chalcocote (light gray).

D: (396, 0F 072)

Chalcocite (white, outer) and digenite-bornite like minerals (light gray, inner).

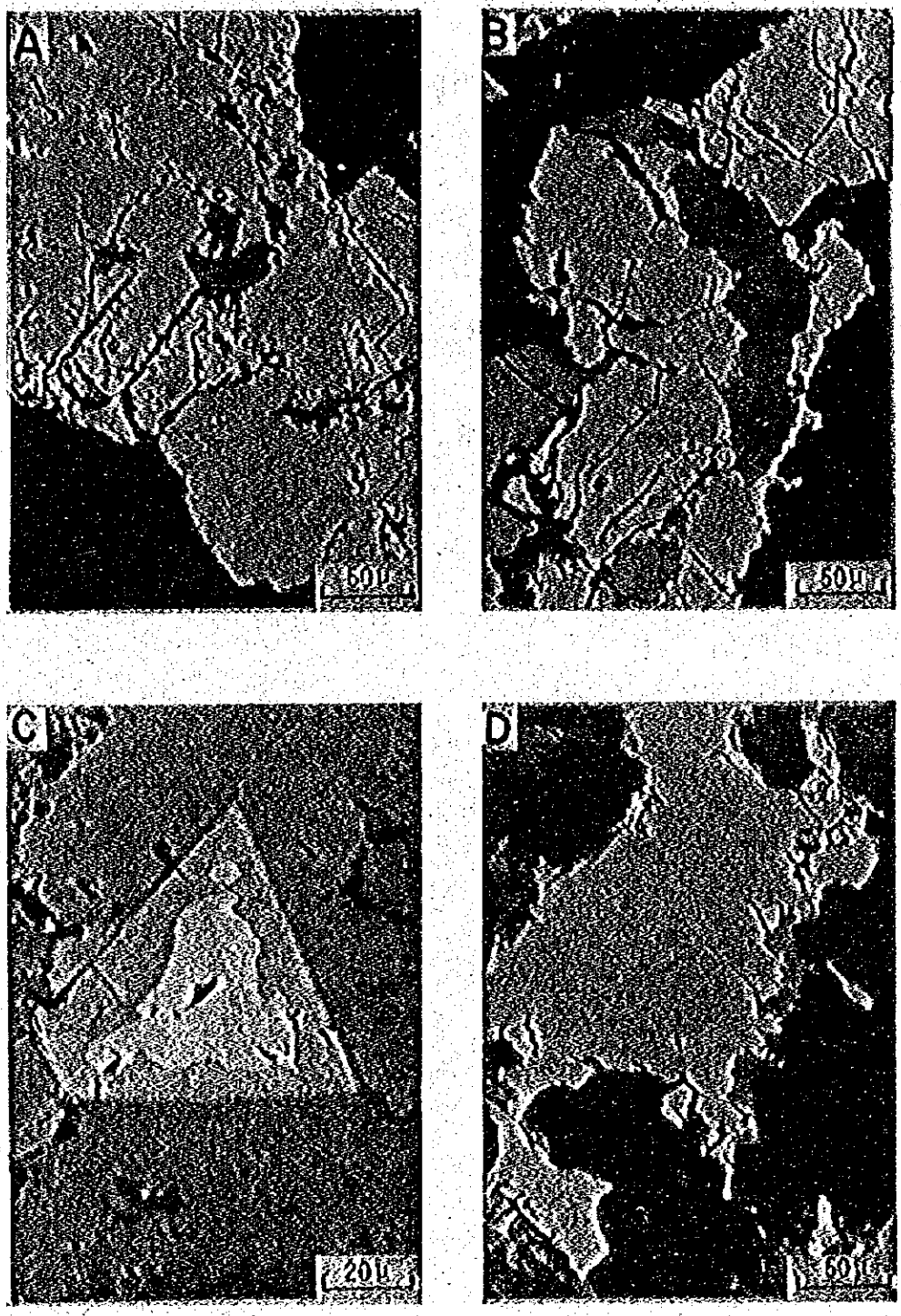

A
50μ
B
50μ
C
20μ
D
60μ

Fig. 12-8 Photomicrographs of Cu-ore III

A: (579, 0I 082)

Pyrite (light gray) and chalcopyrite (gray).

B: (579, 0I 082)

Chalcopyrite (white) replaced by chalcocite-covellite (dark gray rim of chalcopyrite) and iron hydroxide (dark gray, rough surface).

C: (579, 0I 082)

Chalcocite veinlet (gray) replace chalcopyrite (white).

D: (292, A 023)

Spherical pyrite, "mineralized bacteria?"

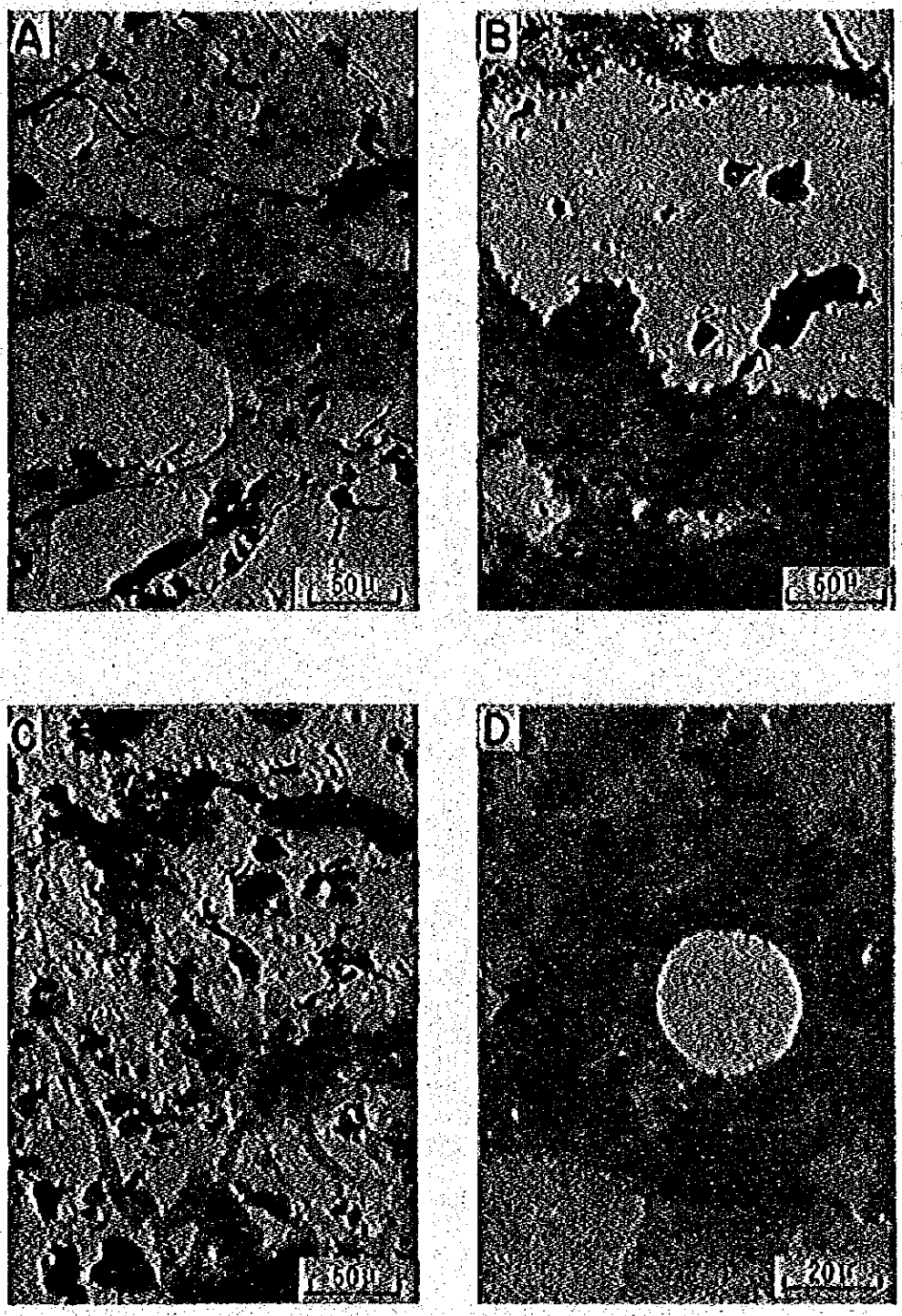

A
B
C
D

Fig. 12-9 Photomicrographs of limonite gossan I

A: (316, D 063)

Skeltal crystal of hematite? (white) in limonite.

B: (381, OP 050)

Aggregate of goethite.

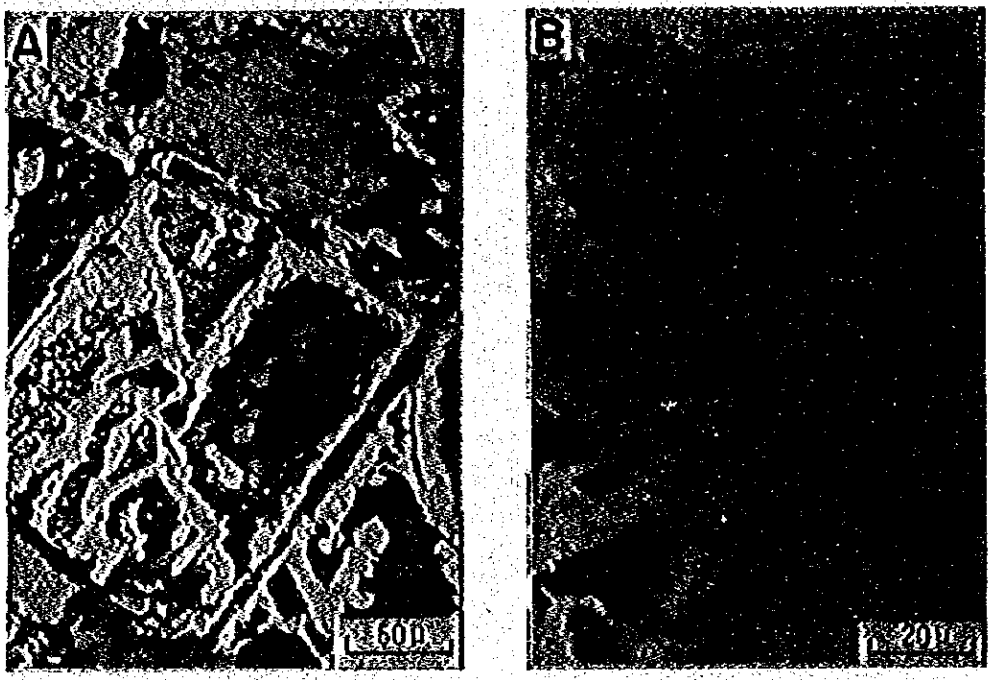

A
B

Table 8. Chemical Composition of Ore Samples

Sample No.	Field No.	Analysis			Remarks
		Cu %	Pb %	Zn %	
220	S014	0.002	0.088	0.025	Crystalline dolomite in the Pucara Group
259	C013A	0.001	0.012	0.018	Crystalline dolomite showing zebra structure (Pucara Group)
264	C021	0.001	0.054	0.030	do.
279	A002	0.004	0.081	0.021	do.
292	A023	0.008	0.420	0.048	Galena minute crystals bearing limestone (Pucara Group) intruded by diorite
293	A024	0.740	0.016	0.066	Copper oxide bearing quartz veinlet in limestone (Pucara Group)
294	A025	0.092	0.032	0.032	Copper oxide bearing limestone (Pucara Group)
306	D009	0.004	0.016	0.013	Crystalline dolomite showing zebra structure (Pucara Group)
316	D063	0.032	0.029	0.058	Limonite vein (15cm in width) in schist
343	0E011	< 0.001	0.005	0.22	Sphalerite minute crystals bearing pegmatite vein in the cretaceous granite
345	0E024	0.001	0.006	0.67	Limonite gossan (Float)
346	0E029	0.002	0.009	0.031	Galena minute crystals bearing Limestone (Float)
348	0E050	0.001	0.059	1.02	Limonite gossan (35cm in width) in the Pucara Group
349	0E287	0.032	71.0	5.60	Galena ore of Pichita Caluga mine in the Pucara Group
350	0E288	2.02	0.69	0.41	Copper Oxide ore of Pichita Caluga Mine
351	0E289	0.048	11.3	41.2	Sphalerite ore of Pichita Caluga Mine
352	0E290	0.003	0.073	0.33	Limonite vein (5cm in width) in limestone (Chonta Group)
362	0F007	0.002	0.27	0.14	Galena minute crystals bearing limestone (Pucara Group)
366	0F017	0.002	15.8	0.63	Galena ore of Quintanilla mine in the Pucara Group
367	0F018	< 0.001	81.3	0.019	do.
381	0F050	0.009	0.040	0.036	Pyrite lens in Breccia dolomite (Pucara Group)
382	0F051	0.005	0.038	0.15	do.
383	0F052	0.001	0.008	0.41	Limonite gossan in zebra dolomite (Pucara Group)
384	0F053	< 0.001	0.036	23.4	Zn ore in zebra dolomite (Pucara Group)
385	0F054	0.001	0.007	0.33	Limonite gossan in zebra dolomite (Pucara Group)
386	0F055	0.001	0.013	21.8	Zn ore in zebra dolomite (Pucara Group)
387	0F056	0.001	0.028	37.8	do. (do.)
388	0F057	< 0.001	0.38	17.3	do. (do.)
389	0F058	< 0.001	0.012	28.0	do. (do.)
392	0F063	0.010	0.061	45.5	do. (do.)
393	0F064	< 0.001	0.038	22.5	do. (do.)
394	0F065	< 0.001	0.029	50.6	do. (do.)
396	0F072	0.16	0.007	0.43	Copper oxide in Silicified limestone (Pucara Group)
457	0G027	0.002	0.83	1.90	Galena and Sphalerite veinlets bearing dolomite (Float)
461	0G079	0.023	0.72	1.09	Pyrite and Sphalerite crystals bearing silicified rock (Float)
468	0G116	0.002	0.041	0.11	Crystalline dolomite showing zebra structure (in Pucara group)
471	0G123	0.008	0.008	0.066	Limonite gossan in the Mesozoic diorite
499	0H020	0.003	2.06	32.7	Galena ore (Float)
503	0H038	0.006	0.010	0.052	Fe ore mineral bearing skarn
504	0H039	0.008	0.038	0.49	do.
579	0I082	0.82	0.002	0.015	Copper oxide ore in the chloritized Mesozoic diorite

Table 9. Chemical and Normative Composition of Igneous Rocks

Sample No.	229	271	287	301	320	324
Field No.	B001	C028	A016	A037	D069	D079
Rock Name	Diorite porpllyry	Microdiorite	Schistose Diorite	Diorite	Granitic Rock	Porphyritic Diorite
Locality	7G	11D	14B	19B	13B	13C
(Chemical composition)						
SiO_2	57.69	48.69	46.19	58.01	67.87	70.33
TiO_2	0.65	1.94	1.90	0.78	0.44	0.46
Al_2O_3	19.17	17.13	19.61	18.77	15.38	14.60
Fe_2O_3	2.48	3.01	4.05	4.33	0.47	1.17
FeO	1.82	6.24	5.61	1.16	2.34	2.27
MnO	0.14	0.15	0.14	0.16	0.06	0.08
MgO	1.10	4.84	4.28	1.07	0.82	0.94
Na_2O	5.27	3.27	2.73	5.02	4.18	3.08
K_2O	4.85	2.33	0.64	3.88	3.36	3.05
H_2O (-)						
H_2O (+)						
P_2O_5	0.19	0.73	0.74	0.24	0.18	0.16
CO_2	0.21	0.67	0.16	0.18	0.97	0.20
CaO	4.24	7.26	10.09	5.61	2.27	2.02
Total	97.81	96.26	96.14	99.21	98.34	98.36
MgO	7.21	24.78	25.31	7.12	7.37	9.05
FeO	26.52	46.24	54.76	33.67	24.82	31.95
$(Na, K)_2O$	66.27	28.98	19.23	59.21	67.81	59.00
(Normative composition)						
Q	0	0	1.56	3.36	26.25	34.83
Or	28.38	13.91	3.90	22.82	20.03	17.81
Ab	44.56	27.79	23.07	42.47	35.13	26.21
An	14.46	25.03	39.22	17.24	4.17	7.79
Ne	0	0	0	0	0	0
Di-Wo	1.86	0.81	2.09	3.14	0	0
Di-En	1.45	0.51	1.40	2.71	0	0
Di-Fs	0.21	0.26	0.54	0	0	0
Hy-En	0.36	10.08	9.24	0	2.01	2.31
Hy-Fs	0.05	5.08	3.55	0	3.30	2.64
Fo	0	0	0	0	0	0
Fa	0	0	0	0	0	0
Mt	3.70	4.40	5.79	1.85	0.69	1.62
Il	1.21	3.64	3.64	1.52	0.91	0.91
Ap	0.34	1.68	1.68	0.67	0.34	0.34
C	0	0	0	0	3.36	3.36
Hy	0	0	0	3.03	0	0
Total	96.58	93.19	95.68	98.81	96.19	97.82

Table 10. Radiometric ages of Igneous rocks

Sample No.	Field No.	Rock Name	Locality	Mineral	Sample Wt. (g)	K(%)	$^{40}_{Ar}R/^{40}K$	air Contami(%)	Age (m.y.)	Remarks
229	B001	Diorite Porphyry	7G	Whole rock	1.0594	4.00	0.000828	53.29	14	The rock occurs as a small stock intruding Chonta Group of late Cretaceous Period in the east of Oxapampa. The microscopic study finds soda-augite from this rock.
271	C028	Microdiorite	11D	Whole rock	1.0461	1.44	0.012828	20.77	208	This rock occurs as batholith and it is heterogeneous.
287	A016	Schistose Diorite	14B	Whole rock	1.0483	0.53	0.017753	24.51	282	This rock occurs as batholith and it has strong schistosity.
301	A037	Diorite	19B	Whole rock	1.0234	3.27	0.001609	15.48	27	The rock occurs as stocks and dykes in Chonta Group, and it has the same charactor as B001 specimen.
320	D069	Granitic Rock	13B	Whole rock	1.0534	2.13	0.013816	4.74	223	This rock occurs as batholith and it is weakly crushed.
324	D079	Porphyritic Diorite	13C	Whole rock	1.0298	2.05	0.010379	11.73	170	This rock occurs as a stock and it is heterogeneous.

$\lambda e = 0.585 \times 10^{-10}\,yr^{-1}$, $40K/K = 1.19 \times 10^{-2}$ atom.%

$\lambda\beta = 4.72 \times 10^{-10}\,yr^{-1}$, $^{40}_{Ar}R$: radiogenic argon 40

Table 11. List of Fossils

Sample No.	Field No.	Stratigraphical Units	Fossils	Estimated Age	Remarks
252	B030	Pucara Group	Euasteroceras ? sp.	Jurassic Sinemurian	Ammonoid
237	B013	Pucara Group	Pentacrinites sp.	Jurassic	Crinoid stem
231	B003 (A)	Pucara Group	Euasteroceras ? sp.	Jurassic Sinemurion	Ammonoid
	B003 (B)	Pucara Group	Euasteroceras ? sp.	Jurassic Sinemurian	Ammonoid
255	C006	Chonta Group	Nuculana sp.		Bivalve
			Camptonectes sp.		"
			Namnetia ? sp.	Cretaceous	"
			Lepton ? sp.	Tertiary ?	"
			Arctica ? sp.		"
			Terebratulid Gen. et sp. indet		
			Brachiopoda ? Gen. et sp. indet.		Brachiopoda
			Euechinoidea Gen. et sp. indet		Echinoid
263	C020	Pucara Group	Pseudaganites sp.	Jurassic	Nautiloid
302	A038	Chonta Group	Ostrea (Crassostrea) sp.	Cretaceous	Bivalve
330	D020	Chonta Group	Ostrea (Crassostrea) sp.	Cretaceous	Bivalve
378	PF047A	Pucara Group	Metophiceras sp.	Jurassic Sinemurian	Ammonoid
379	PF047B	Pucara Group	Arnioceras sp.	Jurassic Sinemurian	Ammonoid
451	PG003A	Pucara Group	Pteriidae Gen. et sp. indetermine		Bivalve
452	PG003B	Pucara Group	Bivalve Gen. et sp. indetermine		Bivalve
581	RI089	Pucara Group	Psiloceras planorbis (Sowerby)	Jurassic Hettangian	Ammonoid
618	PCP001	Pucara Group	Epammonites cf. latisulcatus (Quenstedt)	Jurassic Sinemurian	Ammonoid
623	PCP043	Pucara Group	Flabellirhynchia ? sp.	Middle Jurassic ?	Brachiopoda

Fig 13. Photographs of Fossils

Explanation of Plate

Fig. A-1,2,3. Euasteroceras ? sp.

A-1. Right side view of a large but compressed specimen, B030, X 0.9

A-2. Right side view of another compressed specimen, B003A, X 0.8

A-3. Hand specimen showing a crowded occurrence, B003B, X 0.7

Fig. A-4, 5. "Pentacrinites" sp.

A-4a, b. Lateral view, X 2, and cross section, X 4, of pentagonal stems, FB 013.

A-5. Cross section, X 4, of another specimen preserved axial canal, FB 013.

Fig. A-6. Psiloceras planorbis (Sowerby)

Left side view of a slightly compressed specimen,

Fig. A-7, 8. Arnioceras sp.

Left and Right sides views of two compressed specimens,

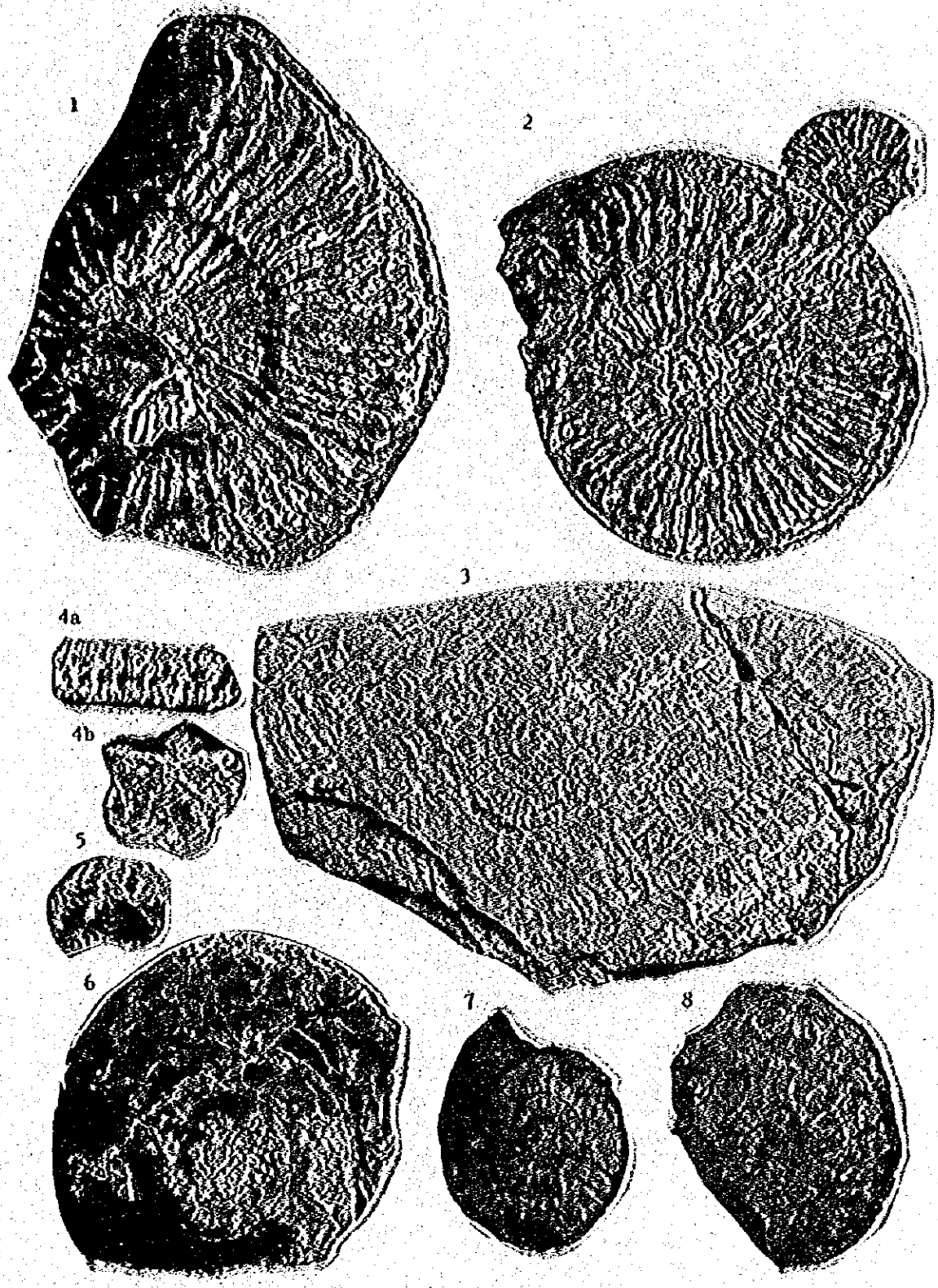


Fig - A

Explanation of Plate

Fig. B-1a, b. Pseudaganites sp.

Right side view and sagittal section on the weatherred surface, C020, X 0.6

Fig. B-2a, b. Pteriidae Gen. et sp. indet.

Internal and external molds of a fragmental left ? valve, G003A, X 1.3

Fig. B-3, 4. Epammonites cf. latisulcatus (Quenstedt)

B-3a, b. Left side, X 1.2 and venttral side, X 1.1, views of a slightly compressed specimen, FCP 001.

B-4a, b. Left and ventral sides views of another specimen, FCP 001 -

Fig. B-5. Metophiceras sp.

Right side view of a compressed rather small specimen, FF FF 047A, X 1

Fig. B-6a~c. Plabellirhynchia ? sp.

Brachial and pedicle valves and lateral view of a fragmental specimen, FCP 043, X 2.5

Fig. B-7, 8. Bivalvea Gen. sp. indet.

Two poorly preserbed specimen, FG 003B, x 1.2

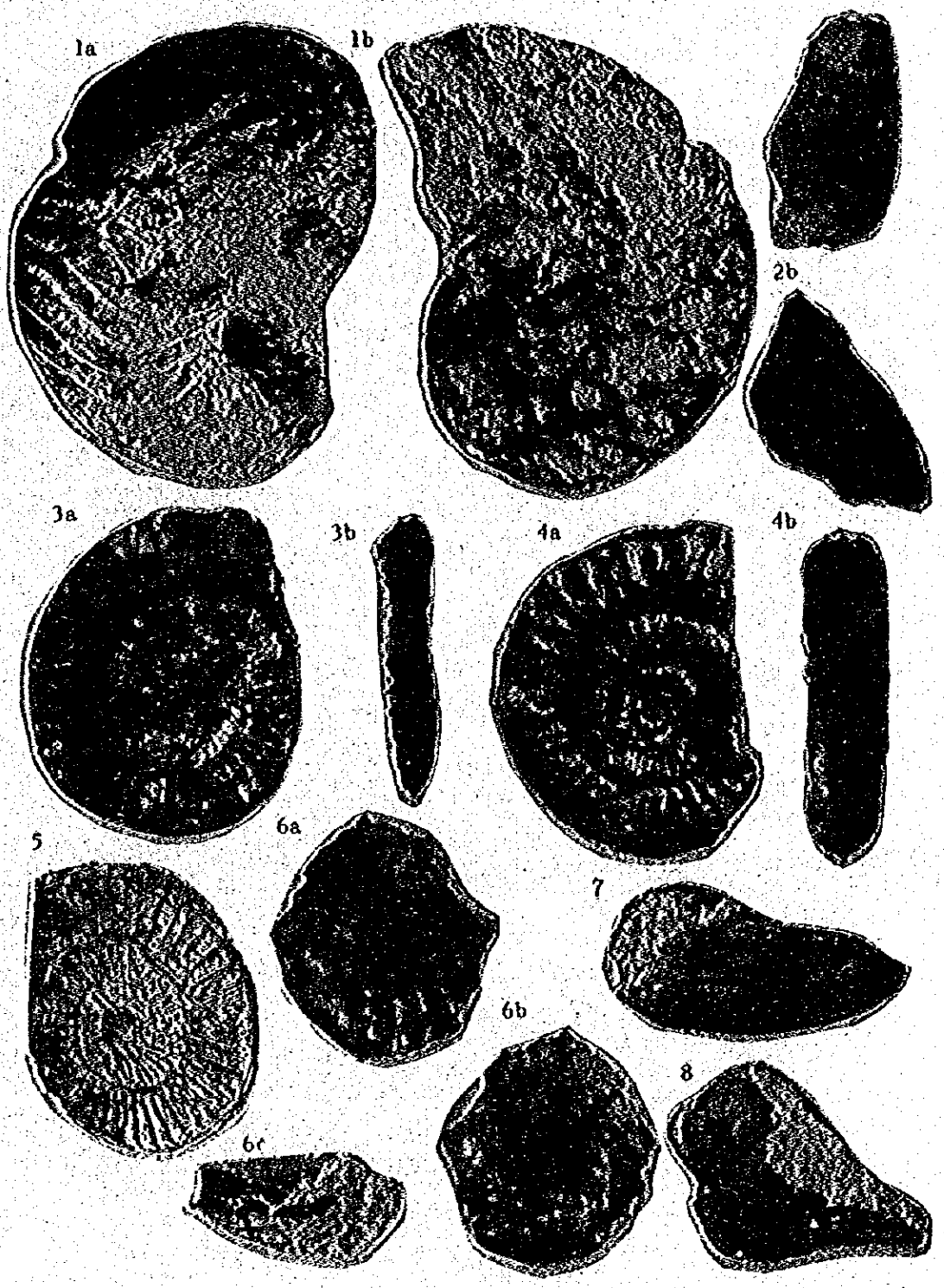


Fig - B

Explanation of Plate

Fig. C-1. Nuculana sp.

Left valve, C006, X 2

Fig. C-2. Camptonectes sp.

Left valve, C006, X 2.5

Fig. C-3. Namnetia ? sp.

Right valve, C006, X 0.9

Fig. C-4. Lepton ? sp.

Right valve, C006, X 1.5

Fig. C-5. Arctica ? sp.

Right valve, C006, X 1.5

Fig. C-6. Terebratulid Gen. et sp. indet.

Brachial valve, C006, X 1

Fig. C-7. Brachiopoda ? Gen. et sp. indet.

C006, X 3

Fig. C-8. Ostrea (Crassostrea) sp.

Left valve, A038, X 0.6

Fig. C-9~13. Euechinoidea Gen. et sp. indet.

C006, X 2.5

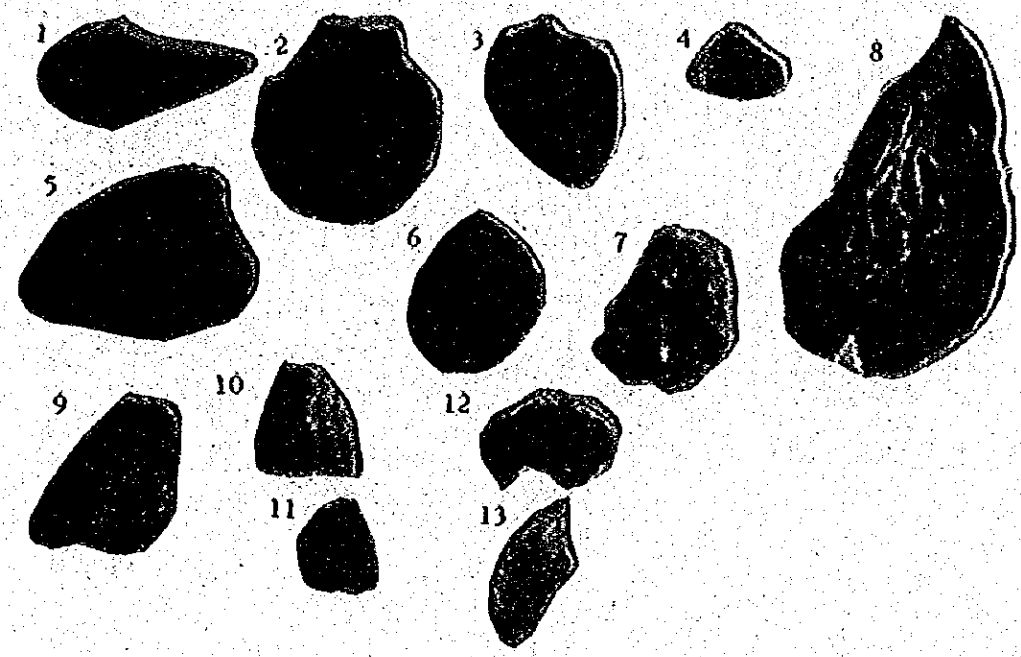


Fig - C

Table 12. Results of Pollen Analysis

Sample No.	Field No.	Locality		Formation	Rock name	Observations
		Coordination	Place name			
281	A007	19B		Tirtiary	Mudstone	The detected pollens consist of Inaperturopollenites, Monoporopollenites, Diporopollenites, Triporopollenites, Monocolpollenites, Tricolporopollenites and pollens of Taxodiaceae, Pinus and etc., which are very few amount. While, very many amounts of spores, which are Monolete spore and some Trilete spores such as Lycopodium?, Gleicheniidites?, Lygodium?, Cingulatisporites? and etc., were detected. Spore fossils occupy more than 85% in total fossils detected. Pollen of Pinus is a spore-type and relatively near recent type, and and most of spores are small in size.
303	D003	19B		Sa	Tuffaceous fine sediment	The very few amounts of pollens and spores were detected. Such pollen as Inaperturopollenites, Monocolpopollenites, Monaporopollenites, Tricolporopollenites and pollens of Taxodiaceae, Pinus and etc. were detected. As a spore, Monolete spore and Trilete spore are recognized.
307	D012	19B		Sa	Shale	Only three pollens such as Tetraporopollenites, Tricolporopollenites and other unknown pollen are recognized. Spore is not detected.
308	D017	18B		Sa	Shale	Although the amounts of microfossils are very few in this sample, such pollens as Inaperturopollenites, Triporopollenites, Tricolporopollenites, Chenopodium and etc. are detected, and as spores, Trilete spores and Monolete spore are recognized. The ratio of pollen and spore is 50:50. The geological age is not sure but may be Mesozoic, because it is generally believed that this type of Trilete spare observed very seldom exists in Tertary.
311	D039	19E		Tertiary	Mudstone	As pollens, Inaperturopollenites, Triporopollenites, Monocolpopollenites, Tricolpopollenites and etc. were detected. While as spores, Trilete spores such as Cingulatisporites and Gleicheniidites, were recognized. Monolete spore and etc. are observed very much. In this sample, Spores are more than pollens, and occupy 81.2% in total amounts of Fossils. The grological are of this sample may possibly be tertiary but comparing this sample with A007, this sample is considered to be little older than A007.