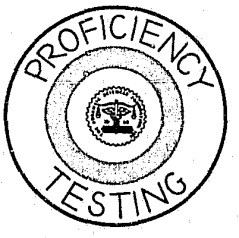
LABORATORY PROFICIENCY TESTING PROGRAM

REPORT NO. 11

SOIL EXAMINATION



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REPORT NO. 11

SOIL EXAMINATION

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FOREWORD

The analysis summarized in this report is the eleventh of a series that will be made in conjunction with this proficiency testing research project.

In the course of this testing program participating laboratories will have analyzed and identified different samples of physical evidence similar in nature to the types of evidence normally submitted to them for analysis.

The results of Test Number Eleven are reflected in the charts and graphs which follow.

The citing of any product or method in this report is done solely for reporting purposes and does not constitute an endorsement by the project sponsors.

Comments or suggestions relating to any portion of this report or of the program in general will be appreciated.

April 1976

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BACKGROUND

This laboratory proficiency testing research project, one phase which is summarized in this report, was initiated in the fall of 1974.

This is a research study of how to prepare and distribute specific samples; how to analyze laboratory results; and how to report those results in a meaningful manner. The research will be conducted in two cycles, each of which will include five samples: a controlled substance; firearms evidence; blood; glass; and paint.

Participation in the program is voluntary. Accordingly, invitations have been extended to 238 laboratories to share in the research. It is recognized that all laboratories do not perform analyses of all possible types of physical evidence. Thus, in the data summaries included in this report, space opposite some Code Numbers (representing specific laboratories) may be blank, or marked "No Data Returned".

Additional evaluations of individual tests will be published in a separate report.

The Project is under the direct control of the Project Advisory Committee whose members' names are listed on the Title Page. Each is a nationally known criminalistic laboratory authority.

Supporting the Project Advisory Committee in their efforts is the Forensic Sciences Foundation with additional support from the Collaborative Testing Systems, Inc. in the areas of statistical presentation.

SUMMARY

Sample #11 consisted of soil samples A, B, and C packaged in glass vials. They were mailed on November 26, 1975 with instructions to handle the samples in a manner similar to like evidence submitted for analysis.

In this test, 236 laboratories were each sent three soil samples that were referred to as Items A, B, and C. Participants were asked three questions: (1) Could Items B or C have common origin with Item A? (2) What information did you develop to arrive at your conclusions in Question 1? (3) What methods and instruments were used?

Of the 236 laboratories, 62 indicated that they do not do soil analysis, 84 did not respond, and 90 responded with data. This represents a participation rate of 52%. Two laboratories responded too late for their results to be included in the report. Table 1 lists the codes for laboratories in each of the first two categories above.

The information in Table 2, Supplier's Characterization of Samples, shows the different locations from which the samples were drawn. Table 3 contains the responses of the three referee laboratories. Table 4 summarizes the responses given for Question 1. Table 5 lists the frequency of reported methods given in the response to Question 2. The seven most frequently used methods are tabulated in Table 6; Table 6c reports the number of labs that use each of these methods and their sequential order. Tables 6d and 6e represent the number of conclusions reached by step and method. Table 7 exhibits the elements reported. Table 8 tabulates the results and methods of each participating laboratory.

No effort was made in the report to highlight areas wherein laboratory improvements might be instigated.

ANNEX A

LAB CODE B-_____

FIGURE 1

☐ CHECK HERE AND RETURN IF YOU DO NOT PERFORM SOIL EXAMINATIONS

DATE RECEIVED IN LAB _____

DATE PROCESSED IN LAB _____

DATA SHEET
PROFICIENCY TESTING PROGRAM

TEST #11
SOIL EXAMINATION

Item A represents a soil sample from a burglary scene. Items B and C represent samples of soil removed from the shoes of two different suspects.

1. Could Items B or C have a common origin with Item A?

	Item B	Item C
Yes	☐	☐
No	☐	☐
Inconclusive	☐	☐

2. What information (qualitative and quantitative) did you develop to arrive at your conclusions in Question 1? Please check all appropriate boxes and provide values where applicable.

   In the left hand column indicate the sequence (1,2,3, etc.) in which the tests were run. Indicate with an asterisk (*) the point where a conclusion was reached, even though subsequent tests were performed for confirmatory purposes. If elemental and/or mineral composition is determined, indicate the elements and/or minerals identified.

Sequence of Testing		ITEM A	ITEM B	ITEM C
_____	Color			
_____	Density Studies			
_____	Microscopic Examination			
_____	Emission Spectroscopy			
_____	X-Ray Diffraction			
_____	X-Ray Spectroscopy			
_____	Other (Specify)_____			

3. Please provide the results obtained with each of the methods and instruments checked in Question 2. (Example: Density Gradient tubes using mixture of bromoform and bromobenzene, etc.) Please provide specific and complete responses. Attach additional sheets if necessary.

Method:

Method:

Method:

4. Additional Comments

DATA SHEETS MUST BE RECEIVED AT THE FOUNDATION OFFICE BY JANUARY 2, 1976

Table 1

Code Numbers of Non-participating Laboratories

THE FOLLOWING LABORATORIES INDICATED THEY DO NOT DO SOIL ANALYSIS

207	276	338	378	404	439	496
208	294	340	386	409	452	497
221	298	341	390	416	459	
224	300	342	391	421	460	
226	301	348	392	426	469	
239	313	350	394	427	471	
247	316	351	399	429	477	
250	326	353	400	436	480	
259	327	355	402	437	484	
270	333	377	403	438	489	

Total Labs = 62

THE FOLLOWING LABORATORIES DID NOT RESPOND

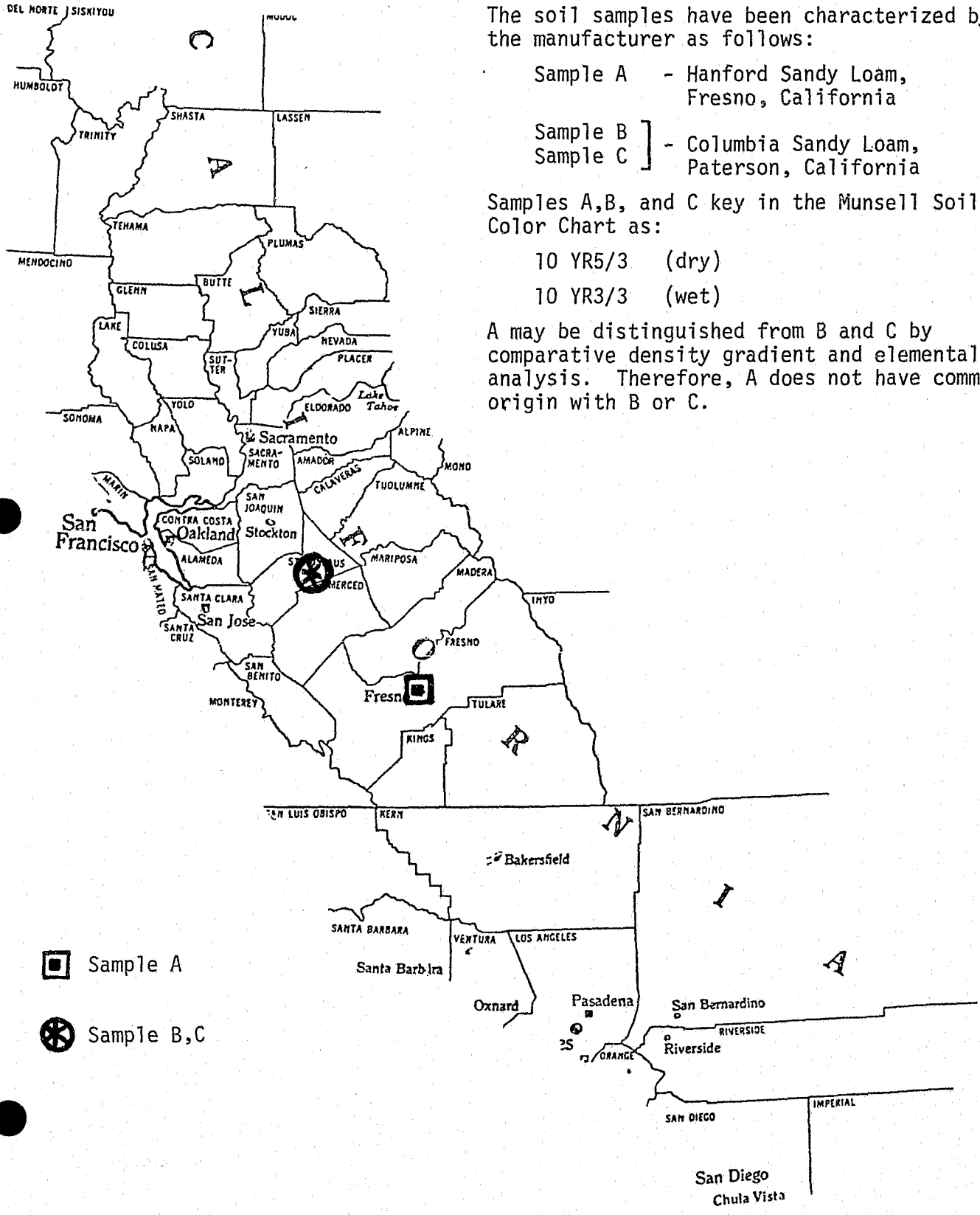
205	274	304	346	376	423	478
213	275	308	349	379	434	483
217	279	311	352	389	435	485
225	280	314	354	393	440	486
228	281	315	360	395	441	494
229	283	319	363	396	445	495
240	284	330	366	401	448	
243	292	335	367	407	454	
248	293	336	368	413	458	
254	296	337	369	414	467	
255	299	339	373	415	472	
262	302	343	374	419	475	
268	303	344	375	420	476	

Total Labs = 84

Note: Responses from laboratories 209 and 269 arrived too late to be included within the body of the report.

Table 2

Supplier's Characterization of Samples



The soil samples have been characterized by the manufacturer as follows:

Sample A - Hanford Sandy Loam, Fresno, California

Sample B, Sample C - Columbia Sandy Loam, Paterson, California

Samples A,B, and C key in the Munsell Soil Color Chart as:

10 YR5/3 (dry)

10 YR3/3 (wet)

A may be distinguished from B and C by comparative density gradient and elemental analysis. Therefore, A does not have common origin with B or C.

Table 3

Results of the Three Referee Laboratories

REFEREE LABORATORY 1

1. Response to Question 1:

   Could Items B or C have a common origin with Item A?

   Item B - NO

   Item C - NO

2. Response to Question 2:

   What information did you develop to arrive at your conclusions in Question 1?

* 1 Color - By eye followed by Munsell Color Charts. Slight difference noted;

   A most closely matches 10 YR 6/4
   B & C most closely match 10 YR 6/3

   2 Microscopic examination

   3 Density Gradient Tubes - (11") Bromobenzene/Bromoform

   1st set 2.2 to 2.89 - Item A appeared to have overall less dense configuration. Expanded tubes prepared from 2.5 to 2.75 confirmed this observation.

   4 Emission Spectrograph - No differences observed. Si, Ca, Cr, Fe, K, Ti, Al, and Mn were detected in all samples. No absolute quantification, comparative only.

* Indicates the point at which a conclusion was reached.

Table 3, continued

REFEREE LABORATORY 2

1. Response to Question 1:

   Could Items B or C have common origin with Item A?

   Item B - NO

   Item C - NO

2. Response to Question 2:

   What information did you develop to arrive at your conclusions in Question 1?

   1 Color - same for all samples.

   2 Microscopic Examination - All samples indistinguishable

   3 Emission Spectroscopy - All samples indistinguishable. Examination by ES. Showed 13 elements: Si, Mg, Ca, Al, Fe, Cu, Pb, Ti, Mn, Na, Mo, Zr, and Nc.

   4 X-ray Diffraction - All samples indistinguishable

* 5 Neutron Activation Analysis - Item A contained significantly more Al, V, Fe, Sc, Sm than did Items B & C. Also found were Mn, Cu, Ba, La, Sb.

An additional examination of the soils by XRF showed the presence of 12 elements in Items A, B, and C. Item A appeared to have 2 additional elements (Ni and Ba) but their peaks were not sufficiently above background for a definite identification. The 12 elements (Si, Ca, K, Ti, Fe, Mn, Cu, S, Cl, Na, Al, and Mg) were observed to have approximately the same concentrations, however some differences were noted. The Cl in Item A was less than B or C and Cu in Item A was higher than B or C. The samples were examined only once, and no fusion, grinding or briquetting was performed.

* indicates the point where a conclusion was reached.

Table 3, continued

REFEREE LABORATORY 3

1. Response to Question 1:

   Could Items B or C have a common origin with Item A?

   Item B - YES

   Item C - YES

2. Response to Question 2:

   What information did you develop to arrive at your conclusions in Question 1?

   1 Microscopic Examination

   2 X-ray Diffraction - The three samples were found to be similar in gross minerology, consisting primarily of quartz, alkali feldspar, and plagioclase.

* 3 Color - estimated by Munsell Color Charts - in direct overhead fluorescent lighting:

   Item A - 2.5Y 7/4-6/4

   Item B - 2.5Y 7/4-6/4

   Item C - 2.5Y 7/4-6/4

   4 Density Gradient - Items A and C gave similar distributions with Item B showing a somewhat different distribution. However, due to fine grain size of the samples, much clumping of particles was evident and it was felt that the results were a reflection of this rather than differences in composition. Thus, the results of this test were ignored.

   5 Emission Spectrographic Analysis - Elemental analysis (qualitative) showed no significant differences among the samples.

   6 Additional Comments - Due to the fact that quantitative analysis was not able to be performed by the laboratory at the time, only qualitative results were found. The differences observed were only differences in relative proportion of components. It was felt that these differences could very likely be the result of variations in sampling within one source area. Hence, the conclusion drawn in Question 1.

* Indicates the point when a conclusion was reached.

Table 4

SUMMARY OF RESPONSES TO QUESTION 1

Question 1: Could Items B or C have common origin with Item A?

	Number of Labs	
Labs Reporting Yes for both B and C	25	(28.4%)
Labs Reporting Yes for B and No for C	2	(2.2%)
Labs Reporting No for both B and C	55	(62.5%)
Labs Reporting No for B and Yes for C	0	
Labs Reporting Inconclusive for both B and C	5	(5.7%)
Labs Reporting No for B and No Response for C	1	(1.1%)
Total	88	(100%)

Comparison	Yes Responses	No Responses	Inconclusive	NR
Item B same as Item A	27 (30.7%)	56 (63.6%)	5 (5.7%)	0
Item C same as Item A	25 (28.4%)	57 (64.8%)	5 (5.7%)	1 (1.1%)

Note: Percentages in parentheses indicate the percentage of total Labs giving that response.

Table 5

Frequency of the Reported Methods Used to Answer Question 2

Question 2: What information did you develop to arrive at your conclusions?

Method	Number of Labs Reporting Use of this Method	Percentage of Responding Labs Using this Method
Color	88	100 %
Microscopic Examination	80	90.9
Density Studies	60	68.2
Emission Spectroscopy	35	39.8
X-ray Spectroscopy	17	19.3
X-ray Diffraction	11	12.5
pH Tests	10	11.4
Microschemical Tests	9	10.2
UV-Fluorescence	6	6.8
Optical Mineralogical Analysis	6	6.8
Particle Size	5	5.7
Ignition Loss	3	3.4
Magnetic Components	3	3.4
Infrared Absorption	2	2.3
UV-Visual Spectroscopy	2	2.3
Turbidometry	2	2.3
Colloidal Suspension	2	2.3
Water Emulsion	1	1.1
Differential Thermal Analysis	1	1.1
Energy Dispersive Analysis	1	1.1
X-ray Light Mineral	1	1.1
Organic Composition	1	1.1
Pyrolysis G-C	1	1.1

Table 6a

Comparison of Item A and Item B by the Seven Most Frequently Reported Methods

Method	Number of Labs Comparing Item A and Item B by this Method	Number of Labs Reporting they Could Differentiate Item A and Item B by this Method	Number of Labs Reporting they Could Not Differentiate Item A and Item B by this Method
Color	77	37	40
Microscopic Exam	62	11	51
Density Studies	50	25	25
Emission Spectroscopy	30	2	28
X-ray Spectroscopy	16	6	10
X-ray Diffraction	11	3	8
pH	10	9	1

Table 6b

Comparison of Item A and Item C by the Seven Most Frequently Reported Methods

Method	Number of Labs Comparing Item A and Item C by this Method	Number of Labs Reporting they Could Differentiate Item A and Item B by this Method	Number of Labs Reporting they Could Not Differentiate Item A and Item B by this Method
Color	77	37	40
Microscopic Exam	62	11	51
Density Studies	50	27	23
Emission Spectroscopy	30	2	28
X-ray Spectroscopy	16	7	9
X-ray Diffraction	11	3	8
pH	10	9	1

Table 6c

Numberical and Sequential Breakdown of the Seven Most Frequently Reported Methods

Method	Number of Labs Using this Method	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Color	88	79	8	0	0	1	0	0
Microscopic Examination	80	6	60	12	1	1	0	0
Density Studies	60	0	7	31	19	0	2	1
Emission Spectroscopy	35	1	0	13	15	5	0	1
X-ray Spectroscopy	16	0	2	7	3	3	1	0
X-ray Diffraction	11	0	1	2	3	4	1	0
pH Tests	10	0	1	2	1	4	2	0

Table 6d

Number of Tests Performed to Reach a Conclusion

Step	Number of Conclusions Reached at this Step	Cumulative Percent (68 Labs)
1	17	25.0%
2	6	8.8
3	21	30.9
4	17	25.0
5	5	7.4
6	0	0
7	1	1.5
8	1	1.5

Note: 20 Labs did not report the point where a conclusion was reached. (i.e., no * shown)

Table 6e

Number of Conclusions Reached From Each of the Seven Most Frequently Used Methods

Method	Number of Conclusions Reached From this Method
Color	15
Microscopic Examination	4
Density Studies	20
Emission Spectroscopy	7
X-ray Spectroscopy	3
X-ray Diffraction	1
pH Tests	2

Table 7

Elements Reported by Participating Labs

Elements		Number of Labs Which Reported Finding the Elements in a Sample
Al	(Aluminium)	22
As	(Arsenic)	1
B	(Boron)	1
Ba	(Barium)	1
C	(Carbon)	1
Ca	(Calcium)	23
Cd	(Cadnium)	1
Cl	(Chlorine)	2
Co	(Cobalt)	1
Cr	(Chromium)	4
Cu	(Copper)	8
Fe	(Iron)	26
Ga	(Galium)	1
Ir	(Iridium)	1
K	(Potassium)	13
Mg	(Magnesium)	20
Mn	(Manganese)	15
Mo	(Molybdenum)	1
Na	(Sodium)	17
Ni	(Nickel)	3
O	(Oxygen)	11
Os	(Osium)	1
Pb	(Lead)	4
Rb	(Rubidium)	3
Rh	(Rhodium)	1
Ru	(Ruthenium)	1
S	(Sulfur)	3
Sb	(Antinony)	
Si	(Silicon)	26
Sr	(Strontium)	7
Ti	(Titanium)	20
V	(Vanadium)	6
Y	(Yttrium)	1
Zn	(Zinc)	7
Zr	(Zirconium)	9

Note: 28 laboratories reported specific elements that they had found in the samples.

Table 8

Detailed Summary of Laboratory Responses

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
201 YY	1	Color		A, B, C similar	
	2	Microscopic Exam		A, B, C similar	
	3	Density Studies		A, B, C similar	
	4	X-ray Diffraction		A, B, C contain Silicon Dioxide	
	5*	Emission Spectroscopy		A, B, C contain Cr, Si, Al, Mn, Fe, Mg, V, Ca, Na, Ti	
202 NN	1	Color		A darker in color than B and C	
	2	Microscopic Exam		A, B, C contain ferrous material	
210 YY	1	Color			
	2	Microscopic Exam			
	3	Density Studies			
211 NN	1	Microscopic Exam			
	2	Color			
	3	Density Studies			
	4	Emission Spectroscopy		A, B, C similar in elemental content	
	5*	pH	4.5	8.0	8.0
212 NN	1*	Color		A darker than B and C	
214 YN	1	Color		No discernable differences	
	2	Microscopic Exam		No discernable differences	
	3	X-ray Spectroscopy		A and B no discernable differences	C contains 2 times Zr level as in A
	1.5	UV		No discernable differences	
	1.6	Magnetic Components		No discernable differences	
215 II	1	Organic Composition		No significant differences noted	
	2	Particle Size		A and B same	C different
	3	Microscopic Exam		A, B and C same	
	4	Density Studies		A and B same	C different
	5	Color		A, B and C same	
	6	Micro Chemical Reactivity		A and B same	C different
216 NN	1*	Color		A darker	B and C match
	2	Microscopic Exam		Minerals appeared similar in all three	
	3	Density Studies		A different	B and C similar with slight difference
218 NN	1	Color		Reddish Tan	B and C tan
	2	Microscopic Exam		A different	B and C same
	3*	Density Studies		A less than B and C	B and C indistinguishable
	4	Emission Spectroscopy		Inconclusive	
	5	X-ray Spectroscopy		A greater than B and C	B and C less Cu and Zn than A
219 YY	1	Color		A, B, C light brown	
	2	Microscopic Exam		A, B, C same	
	3	Density Studies		A, B, C similar	
	4*	Emission Spectroscopy		A, B, C same	
223 YY	1	Color			
	2	Microscopic Exam			
	3	Density Studies			
	4	Emission Spectroscopy			
227 NN	1*	Color		A darker brown than B and C	
	2	Microscopic Exam		No differences noted	
	3	Density Studies		A slightly different than B or C	
	4	Emission Spectroscopy		No differences detected	
	5	pH		A more acidic	
	6	Ignition Loss		A has a greater ignition loss than B or C	
233 NN	1	Color		No observable differences	
	2	Microscopic Exam		No observable differences	
	3*	Density Studies		A different	B and C same
	4	Visable UV Absorption Spectra of Water Extract		All give peak for peak similar spectra; however intensities of B and C are the same and greater than that of A.	
236 NN	1*	Color	pale brown 10 YR, 6/3	lt. brownish 2.5Y 6/2	lt. brownish gray 2.5Y 6/2
	2	X-ray Spectroscopy	Si/Fe .353	Si/Fe .404	Si/Fe .406
237 NN	1*	Color	Darker	B and C lighter	
	2	Particle Size Distribution		No difference	
	3	Low-power Microscopy	Coated	B and C grains clean	
238 NN	1	Color	Slightly different	B and C indistinguishable	
	2*	Non-dispersive X-ray	Al, Si, K, Ca, Ti, Mn, Fe, traces of Sr	Al, Si, K, Ca, Ti, Mn, Fe, Sr	Al, Si, K, Ca, Ti, Mn, Fe, Sr
	3	Microscopic Exam	A different	B and C indistinguishable	
	4*	Differential Thermal Analysis			
	5	Emission Spectroscopy		A, B, C contain Mg	
246 NN	1	Color		A, B, C, similar	
	2	Microscopic Exam		A, B, C, similar comparison	
	3*	Density Studies	A different	B and C similar	
	4	pH	6.8	9.5-9.8	9.5-9.8
	5	Turbidometry	3.0%T	4.6%T	4.6%T
249 NN	1*	Color	Brown-golden	Brown-tan	Brown-tan
	2	Microscopic Exam			
	3	Density	A different	B and C same	
251 YY	1	Color			
	2	Microscopic Exam			
	3	Density Studies			

* indicates the point where a conclusion was reached

Note: NN indicates response of No for Item B and No for Item C (Question 1)
YY indicates response of Yes for Item B and Yes for Item C (Question 1)
YN indicates response of Yes for Item B and No for Item C (Question 1)
II indicates response of Inconclusive for both Items B and C (Question 1)
NNR indicates response of No for Item B and No Response for Item C (Question 1)

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
252 NN	1	Color	A Slightly darker than B or C		
			No difference under UV light		
	2	Microscopic Exam	No observable differences		
	3	Emission Spectroscopy	No differences, all have Na, Ca, Mg, Fe, Al, Si		
	4	Density Studies	Relative densities the same		
	5*	Chemical Reaction	A does not effervess	B and C effervescs with H_2SO_4, HCl, HNO_3	
253 II	1	Color	A, B, C light tan		
	2	Microscopic Exam	Mica, quartz in all three samples		
	3	Emission Spectroscopy	U.S.G.S. 31 element comparison		
	4	U.V. Fluorescence	All negative		
256 NN	1	Color	A,B,C light yellowish-brown		
	2	Microscopic Exam			
	3*	Density Studies			
257 NN	1	Color	Brown	Lt. Brown	Lt. Brown
	2	Density Studies	2.7 ave	2.7 ave	2.7 ave
	3	Microscopic Exam	Glass grag K-spar sHb Vermicrilite Plag Qts	K-spar, Hb, Qt_3 Vermiculite Plug	K-spar, Hb Qt_2 Vermiculite Plug
	4*	Water Suspension Tube			
		Silt and Clay	20%	15%	16%
		Sand	80%	85%	84%
		After 24 hours			
		Supernate	Clear	Dark Brown	Dark Brown
258 NN	1	Color			
	2	Microscopic Exam			
	3	Emission Spectroscopy			
	4	Spot Test			
		DPA	Turns green	Turns blue	Turns blue
		H_2SO_4	No eff.	Eff.	Eff.
260 NN	1*	Color			
	2	Microscopic Exam			
	3	Emission Spectroscopy			
261 NN	1	Color	Slightly different shade		
	2	Microscopic Exam	No significant differences noted		
	3	X-ray Fluorescence	$\frac{Fe\ K\alpha}{Ca\ K\alpha}$ = 10.7	$\frac{Fe\ K\alpha}{Ca\ K\alpha}$ = 9.6	$\frac{Fe\ K\alpha}{Ca\ K\alpha}$ = 9.4
	4*	Density Studies	Less dense than B and C		
264 NN	1	Color	Slight difference		
	2	X-ray Diffraction	Whole sample showed minor differences		
	3	Microscopic Exam	Binocular indicates no difference		
	4	Petrographic microscope Light and Heavy	Significant differences in plagioclase and Kspar composition		
	5*	X-ray-Light Minerals			
266 NN	1	Color	Brown	Lt. Brown	Lt. Brown
	2	Microscopic Exam	A,B, C sand and clay		
	3*	Density Studies	A,B, C gradient		
	4	IR	A different from B or C		
273 NN	1	Color			
	2	Microscopic Exam			
	3	Density Studies			
277 II	1	Color	A, B, C same		
	2	Microscopic Exam	A, B, C same		
	3*	Density Studies	A, B, C same		
278 NN	1	Color	A darker than B or C		
	2*	Density Studies	A different from B and C		
	3	Optical Mineralogic Analysis	A, B, C similar		
282 YY	1	Color	No differences noted under visual, long and short wave UV		
	2	Microscopic Exam			
	3	Emission Spectroscopy	A, B, C contain Fe, Mg, Mn, Si, Ca, Na, Ti, Al		
	4*	Density Studies	A, B, C similar		
285 YY	1	Color	A, B, C same		
	2	Microscopic Exam	A, B, C same		
	3	X-ray Fluorescence	A, B, C contain Al, Si, K, Ca, Ti, V, Mc, Fe, Sr, Rb, Zr		
	4*	Density Studies	A, B, C same		
	5	Pyrolysis G-C	A,B, C have same pyrogram		
290 NN	1	Microscopic Exam	Results inconclusive		
	2	Color	Results inconclusive		
	3*	Water Emulsion	A different	B and C same	
291 NN	1	Color	A slightly darker		
	2	Microscopic Exam	No differences noted		
	3	Emission Spectroscopy	No differences detected		
	4*	Density Studies	A less dense		
	5	pH	A different		
295 NN	1	Color	No differentiation		
	2	Microscopic Exam	Orange Fluorescence		
	3*	Density Studies	A different		
	4	X-ray Spectroscopy	No differentiation		
297 YY	1	Color	A, B, C similar		
	2A	Microscopic Exam	A, B, C similar		
	2B	IR	A, B, C same		
	3*	Density Studies	A, B, C similar		

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
307	1	Color		A, B, C tan	
NN	2	Density Studies	A different		
	3*	Emission Spectroscopy	A contains more Zr	A, B, C contain Fe, Si, Al, Mg, Mn, Ca, Zr, Ti, V	
	4	Microscopic Exam		A, B, C, same	
309	1	Color		A, B, C same	
YY	1	Microscopic Exam		A, B, C, same	
	2*	X-ray Spectroscopy		A, B, C, same	
	3	X-ray Diffraction		A, B, C, same	
310	1	Color	Darker	Lighter	Lighter
NN	2*	Microscopic Exam			
	3	Density Studies			
312	1	Color	Particle color and distribution - appearance similarities when rotated		
YY	2	Microscopic Exam			
	3*	Density Studies			
	4	Emission Spectroscopy	Elements Fe, Mg, Ca, Al, Si, Na		
317	1	Color		A, B, C, grayish brown	
NN	2	Microscopic Exam		All items transparent and opaque minerals	
	3*	Density Studies	A different		
	4	Emission Spectroscopy		A, B, C contain Si, Mg, Mn, Al, Ga, Ca, Fe, Sb, Cu, Ni, Ti, Zr, K	
	5	X-ray Diffraction		A, B, C, comparison	
	6	Polarizing Light Microscopy		A, B, C contain limonite, quartz, orthoclase feldspar, plagioclare feldspar, several opaque minerals, hornblend, iron pyrite, magnetite	
	7	pH	5-6	6-7	6-7
320	1	Color			
YY	1a	Grain Size			
	2	Microscopic Exam			
	3	Density Studies			
324	1	Color	A slightly different	B and C similar	
NN	2	Microscopic Exam			
	3	Colloidal Suspension	Less sand	B and C contain more soluble material than A	
	4*	Density Studies		A, B same	C different
325	1	Color	A darker		
NN	2	Microscopic Exam		No noticable differences	
	3	X-ray Spectroscopy	Mn not present	B and C contain Mn	
345	1	Microscopic Exam		No difference found	
YY	2	Color		A, B, C same	
	3	UV		No fluorescence	
	4	Density Studies		Same density	
	5	Emission Spectroscopy		Same spectra	
347	1*	Color	Darker tan	Lighter tan	Lighter tan
NN					
356	1	Color			
NN	2	Microscopic Exam			
	3*	Emission Spectroscopy			
	4	Density Studies			
	5	Tests for Chloride, Sulfate, Nitrate		A, B, C, negative	
359	1	Color		A, B, C, same	
YY	2	Microscopic Exam		A, B, C, same	
	3	Density Studies		A, B, C, same	
	4*	Emission Spectroscopy		A, B, C, same	
370	1	Color			
NN	2	Sieving			
	3*	Microscopic Exam			
371	1	Color	A different		
II	2	Microscopic Exam		A, B, C, same	
	3	Ashing (wt. loss)	1.99%	1.97%	1.91%
372	1	Color	10 yr 6/3-6/4	10 yr 6/3	10 yr 6/3
NN	2	Microscopic Exam			
	3*	Analysis Mineral		B and C slightly different in mineral composition than A	
380	1	Color	A dissimilar		
NN	2	Microscopic Exam	A different		
	3	Density Studies	A different		
	4	X-ray Fluorescence	A different		
381	1	Microscopic Exam			
II	2	Color			
	3*	Density Studies			
384	1	Color		A slightly darker	
YY	2	Microscopic Exam		Same mineral content	
	3	Density Studies		Similar density	
	4	Emission Spectroscopy		Same elements present	
385	1	Color		Light reddish, grayish brown	
YY	2	Microscopic Exam		Fine sandy soil with quartz plagioclase and 3% heavy minerals	
	3*	X-ray Spectroscopy	Major: Fe, Si Minor: Sr, Ca Trace: Ti, Zn, Mn, K		
	4	X-ray Diffraction			
387	1	Color	Slightly darker		
YY	2	Density Studies		No significant differences	
	3	Microscopic Exam		A,B, C contain quartz, feldspar (microcline, orthoclase), hornblende, magnetite, obsidina, vermiculite and zircon	
	4*	Emission Spectroscopy		No significant differences	
388	1*	Color	Dark	Light	Light
NN	2	Microscopic Studies		A, B, C, same	

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
397	1, 2	Color			
YY	3*	Microscopic Exam			
398	1	Color	Lt Yellow-Brown to yellow brown	Light Yellow brown	Light Yellow brown
NN	2	pH	7.0	10.0	10.0
	3	X-ray Diffraction	Different from B and C		
	4	X-ray Spectroscopy	Different from B and C		
	5	Microscopic Exam	More heavy minerals, magnetite, biatite than B or C. Lime-stone absent.		
	6	Spot tests for NO_3	Lower than B or C		
	7	Mineralogical	Different from B and C		
	8	Turbidity of Washings	Settles clea in. 20 minutes	B and C brown liquid 20 minutes	
406	1*	Color	Reddish Brown A is blacker than B and C after charring	B and C light reddish brown	
NN	2	HCl	No effervescence for A, B, C		
	3	Microscopic Exam	Similar grain morphology		
	4	Density Studies	≅ 5% heavy minerals	≅ 5% heavy minerals	≅ 4% heavy minerals
	5	Microscopic Exam	Similar minerals in A, B, C		
	6	Magnetic Susceptibility of Heavy Mineral Fraction	Similar results for A, B, C		
	7	Emission Spectroscopy	Similar elemental composition heavy and light meneral fractions		
408	1	Color	No apparent differences noted		
NN	2	Microscopic Exam	A does not bubble with HCl		
	3	pH	8.9	8.4	8.4
417	1	Microscopic Exam	A, B, C appear similar in sieve gradient		
NN			A different compactibility	B and C similar compac-tibility	
	2	Color	No visual differentiation		
	3	Emission Spectroscopy	A dissimilar		
418	1	Color	A, B, C same		
NN	2	Microscopic Exam	Red granules		
	3	Emission Spectroscopy	22 elements in A, B, C		
	4*	Density Studies	Lighter	Heavier	Heavier
	5	CO_3	Tr	+	+
422	1	Color	No difference		
YY	2	Microscopic Exam	General appearance match		
	3	Magnet	Black ferromagnetic particles in all three samples - magnetite?		
	4	Luminescence under long and short wave UV	No luminescence observed		
	5	Polarizing microscope	Apparent silica particles are birefringent Green birefringent particles in A,B,C		
	6	Density Studies	No difference observed		
	7	pH of H_2O extract	Same for A,B, C approximately pH 6		
	8*	Effect of HCl	No effervescence		
428	1	Color	A, B, C similar		
NN	2	Microscopic Exam	A, B, C similar		
	3	X-ray Spectroscopy	A, B, C similar		
	4	Density Studies	Some differences, unable to interpret		
	5*	pH	B and C more alkaline		
430	1	Color	A, B, C brown		
YY	2	Microscopic Exam	A, B, C contain sand, mica, black debris		
	3	Density Studies	A, B, C similar		
	4*	Emission Spectroscopy	A, B, C similar		
	5	X-ray Diffraction	Inconclusive		
431	1	Color	Brown	Lt. Brown	Lt. Brown
YY	2	Microscopic Exam	Quartz, hornblende, chromite		
	3	Density Studies	Qualitatively similar		
	4*	Emission Spectroscopy	Na, Ca, Si, Mg, Mn, Al, Fe Trace amounts of Sr, Cr, K		
432	1	Color	A, B, C similar		
NN	2	Microscopic Exam	A, B, C similar		
	3*	UV - Vis. Spectroscopy	A dissimilar	B and C similar	
433	1*	Color	A different		
NN	2	Density Studies	A different		
443	1	Emission Spectroscopy	Same elements		
NN	2	Color			
	3	Microscopic Exam			
	4*	Density Studies	A different		
444	1*	Color	A slightly darker		
NN	2	Microscopic Exam	Appeared similar		
	3	Density Studies	A different		
	4	Emission Spectroscopy	A, B, C similar. Contain Co, Al, Ch, Cu, Si, Mg, Fe, Na, Ti		
446	1	Color	A, B, C same		
YY	2	UV Light	A, B, C same		
	3	Microscopic Exam	A, B, C same		
	4	Density Studies	A, B, C same		

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
449 NN	1*	Color	Darker and more reddish		
	2	Density Studies	Showed more lighter materials		
450 NN	1	Microscopic Exam	A, B, C appeared identical under the microscope		
	2	Color	All colors indistinguishable		
	3	X-ray Fluorescence	All samples gave identical elemental composition		
	4	Density Studies	A showed a broader range of density than B and C		
	5	X-ray Diffraction	A give different pattern than B or C		
453 NN	1	Color	All similar tan color		
	2	Microscopic Exam			
	3*	Microchemical Tests	A different		
	4	X-ray Diffraction	No significant differences		
	5	X-ray Spectroscopy	Similar ratios of major elements		
	6	Density Studies	A different		
455 NN	1	Color	A darker		
	2*	Microscopic Exam	Finer texture		
	3	Density Studies	A lighter		
	4	Emission Spectroscopy	Same elements in all		
	5	X-ray Fluorescence	Intensity differences bu same elements in all		
462 NN	1*	Color	A different		
	2	Microscopic Exam	A does not contain mica		
465 YY	1	Color	A,B,C light brownish gray (2.5 Y 6/2)		
	2	Microscopic Exam	A,B,C, black, glassy and orange particles		
	3	Emission Spectroscopy	No differences observed		
	4*	X-Ray Diffraction	Patterns similar		
468 NN	1	Color	A dissimilar to B or C in 100 and 200 Fine Cut		
	2	Microscopic Exam	No individualizing characteristics were noted		
	3*	Density Studies			
470 YY	1	Color	A, B, C same		
	2	Density Studies	A, B, C same		
	3	Emission Spectroscopy	A, B, C match		
473 NN	1	Color	No differences observed (all three)		
	3	Microscopic Exam	No gross differences observable		
	2*	X-ray Spectroscopy	A different - B and C not observably different		
	4	Density Studies	B and C had finer consistency than A. No differences between B and C		
474 NN	1*	Color (Used Munsell Color Chart)	Hue 10 YR 5/3	Hue 10 YR 6/4	Hue 10 YR 6/3
	2	Microscopic Exam	No differences noted		
	3	pH	5	8	8
	4	UV - light	No differences noted		
	5	Emission Spectroscopy	Si, Mn, Mg, Fe, Ca, Na, Al, Cu, Cd sound in all samples		
	6	X-ray Diffraction	No differences noted		
	7	Density Studies	Difference noted in each sample		
479 NNR	1*	Color		Color does not compare to A	Color does not compare to A
481 NN	1*	Color	Reddish Brown	Lt. Brown	Lt. Brown
	2	Microscopic Exam	Presence of Fe filings in all three samples		
	3	Energy Dispersive Analysis of X-rays	B and C have trace amounts of Cl and S Sample A, B, C contain Na, Al, Si, K, Ca, Ti, Fe		
482 YY	1	Color	A similar to B and C	B = C	C = B
	2	Microscopic Exam	A similar to B and C	B = C	C = B
	3	Density Studies	A similar to B and C	B = C	C = B
	4	Emission Spectroscopy	A = B = C		
	5	X-ray Diffraction	A = B = C		
	6	X-ray Spectroscopy	A = B = C		
	7*	Ignition	A similar to B and C	B = C	C = B
493 YY	1	Color	All three samples were light brown with the same consistency		
	2	Microscopic Exam	All three samples appeared the same		
	3	Emission Spectroscopy	All samples contained Si, Al, Fe, Mg, Ca, and Na All samples contained trace elements Ti, Mn, and Zr		
	4*	Density Studies	Each sample had the same density between 2.542 and 2.890		
499 YN	1	Color	No differences noted in color		
	2	Microscopic Examination	No differences noted		
	3	Density Studies	All samples apparently identical in density distribution		
	4*	Particle Size Distribution			C different from A and B in mesh fractions 100, 150 and >150
	5	Emission Spectroscopy	No apparent qualitative differences		

* indicates the point where a conclusion was reached

END