



DEPARTMENT OF
ENERGY, MINES AND RESOURCES
MINES BRANCH
OTTAWA

*THE FLOATABILITY OF
TWENTY-ONE NON-METALLIC
MINERALS*

R. A. WYMAN

MINERAL PROCESSING DIVISION

JANUARY 1969

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THE FLOATABILITY OF TWENTY-ONE NON-METALLIC MINERALS

by

R. A. Wyman*

ABSTRACT

The floatabilities of twenty-one non-metallic minerals as affected by pH regulators, collectors and modifiers have been determined. Symbols have been used in presentation of results to afford ease of comparison.

The work herein reported extends that contained in Technical Bulletin TB 70, "The Floatability of Eleven Common Non-Metallic Minerals" (April 1965). Ten additional minerals are included and fourteen additional collectors.

This project is intended to assist those working on the floatation of non-metallic minerals.

*Head, Industrial Minerals Milling Section, Mineral Processing Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Direction des mines

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LA FLOTTABILITÉ DE VINGT ET UN MINÉRAUX NON MÉTALLIQUES

par

R. A. Wyman*

RÉSUMÉ

La présente étude fait état de l'action des régulateurs de pH, des agents collecteurs et des agents modificateurs sur la flottabilité de vingt et un minéraux non métalliques. Afin de simplifier la comparaison, on a utilisé des symboles pour la présentation des résultats.

Ces données représentent une extension des études contenues dans le Bulletin technique TB 70, intitulé "La flottabilité de onze minéraux communs non métalliques", publié en avril 1965. Dix nouveaux minéraux ont été inclus, ainsi que quatorze agents collecteurs supplémentaires.

Ces travaux ont été entrepris en vue d'aider les chercheurs dans le domaine de la flottation des minéraux non métalliques.

* Chef de la Section de traitement des minéraux industriels, Division du traitement des minéraux, Direction des mines, ministère de l'Énergie, des Mines et des Ressources, Ottawa, Canada.

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Cartier
La Rose

INTRODUCTION

For a number of years the Industrial Minerals Milling Section employed a small-scale test to aid in solving floatation problems. The test method was simple and direct. It was intended to be indicative rather than definitive, a guide rather than a solution.

Because the information obtained has proved helpful in solving a number of floatation problems, it was decided to publish the results. Technical Bulletin TB 70 was issued in 1965 and presented the results of approximately 4000 of the small-scale experiments, designed to indicate the floatability of eleven non-metallic minerals under a variety of conditions. Its purpose was to point out possible new approaches for the separation of non-metallic minerals by floatation, particularly where separation is now difficult, and to suggest possible methods of separation for minerals for which no effective system is presently known.

The work has since been extended to approximately 14,000 of the small-scale experiments. These have indicated the floatabilities of twenty-one non-metallic minerals under a variety of conditions. It is the purpose of this report to present these data in a readily usable form.

SCOPE

The responses of 21 non-metallic minerals to 31 different collectors under acid, neutral and basic conditions are indicated. The effects of six common modifiers on these responses are shown.

EXPERIMENTAL PROCEDURE

Minerals to be investigated are obtained in the purest form available, as crystals where possible. Each mineral is pulverized, and the 28 to 325-mesh fraction is isolated. This fraction is selected because most floatation is done within this size range and a rough visual estimation of the number of particles picked up by a bubble can be made.

These individual fractions are rinsed lightly with dilute HCl and then washed with distilled water to neutral pH. The intent is to cleanse the surfaces without etching or altering them significantly. Each mineral is stored in a clean bottle in distilled water.

The apparatus used consists of a small turntable, a beaker, a stirring rod, and a glass tube with a rubber eyedropper bulb and screw clamp at its top. Before an experiment, the beaker, stirring rod and glass tube are rinsed with chromic-acid cleaning solution and washed thoroughly with distilled water. Measuring devices such as graduates and pipettes are similarly cleaned once or twice per day.

A single experiment consists of the following steps:

- 1) About 100 ml of distilled water is put into the beaker.
- 2) A small quantity (about 0.01 g) of the particular mineral to be examined is added.
- 3) The pH regulator, if used, is added and mixed by stirring rod.
- 4) Modifier (to give 0.05 gpl concentration), if used, is added and mixed by stirring rod.
- 5) Collector to give 0.1 gpl concentration is added and mixed by stirring rod.
- 6) The beaker is placed on the turntable. The bubble tube is lowered vertically until its tip is about a half-inch above the mineral.
- 7) The screw clamp on the rubber bulb is turned to produce a bubble at the lower end of the glass tube.
- 8) The beaker and turntable are raised until the bubble makes contact with the mineral.
- 9) The beaker is lowered until the bubble and adhering particles are surrounded by the liquid.
- 10) Particles adhering to the bubble are estimated (none, one, two, ten, fifteen, etc.).
- 11) The glass tube is lightly tapped and the tenacity with which the particles cling to the bubble (i.e. poor, fair or good) is estimated.
- 12) These estimations are recorded on a standard form.

The experiments progress from simple to more complex. The first step for each mineral is to run a blank, i.e., the bubble is placed in contact with the mineral in distilled water only. With many minerals, several particles will be picked up but may drop off as soon as the tube

is tapped lightly. Each mineral is then tested for response to each collector in turn, under acidic, neutral and basic conditions. In the neutral case, the system consists only of the mineral and the collector in distilled water. For acidic conditions, 1 ml of H_2SO_4 of a predetermined concentration is added from a 1-ml dispensing bottle. The acid is of such a concentration that when 1 ml is added to 100 ml of distilled water a pH of 3.0 will result. Similarly, for basic conditions, 1 ml of Na_2CO_3 of predetermined concentration is added from a 1-ml dispensing bottle, producing a pH of 10.0 in 100 ml of distilled water. For both the acidic and basic experiments the regulator is mixed-in by stirring and the collector is added and also mixed-in by stirring, before bubble contact is made.

The pH will vary slightly during the experiment, owing to the presence of the mineral and the other reagents. However, the quantity of both mineral and reagents is comparatively small and the operations are conducted rapidly. It has been found that the pH varies little from that of the acid or base in distilled water. The maximum change in pH is observed when ionizing modifiers are used. Since the general acidic or basic nature of the system is not altered, however, and the total variation is rarely beyond one pH point, it is considered preferable not to readjust the pH to the specified points. This would add greatly to the time required to perform an individual acidic or basic experiment. Moreover, since the observations are not absolute, the over-all results must be considered as relative only. The one operation with any significant bias is that for "neutral" when HF is used as a modifier. The pH in this case is always slightly on the acid side. However, this would also be the case in larger-scale floatation practice.

In experiments with modifiers, each system - mineral, collector, and pH control - is repeated with each modifier. The modifier is added before the collector and mixed by stirring.

MINERALS INVESTIGATED

The condition in selecting minerals for this study was that they come from natural occurrences and be nearly pure. The geographical origin of some of the minerals used could not be ascertained. With the exception of talc, all are crystalline. Minerals herein reported upon are as follows:

	<u>Mineral</u>	<u>Colour</u>	<u>Origin</u>
1.	Albite	White	Ontario ?
2.	Apatite	Green	Quebec ?
3.	Barite	Buff	B. C.
4.	Beryl	Pale green	Manitoba
5.	Biotite	Black	Ontario
6.	Calcite	White	Ontario ?
7.	Celestite	White	N.S. ?
8.	Corundum	Purple-grey	Madagascar
9.	Fluorite	Purple, green	Newfoundland ?
10.	Garnet	Deep red	Ontario
11.	Gypsum	Transparent	N.S.
12.	Hornblende	Black	Ontario
13.	Kyanite	Greenish blue	Ontario
14.	Magnesite	Off white	Ontario
15.	Muscovite	Transparent	Ontario ?
16.	Orthoclase	White	Ontario ?
17.	Quartz	Transparent	Ontario ?
18.	Spodumene	Light greenish	Manitoba
19.	Talc	Greenish (schistose)	Quebec
20.	Topaz	Transparent, tan	Brazil
21.	Vermiculite	Dark grey	Ontario

COLLECTORS INVESTIGATED

The principle of collection in floatation is simple - to render the surfaces of the mineral to be floated hydrophobic, thus allowing attachment to an air bubble and elevation to the surface. In theory this should be possible with any mineral. In practice there are many complicating factors, and finding a chemical that will be selective for one specific mineral in a mixture of minerals is by no means easy.

Since the mineral surface is the site of the action, the chemicals involved are the so-called surface-active agents (or surfactants). Broadly, these agents fall into three classes according to their activity - non-ionic, anionic, and cationic. Non-ionic agents do not ionize in solution. When anionic agents are dissolved, the negative ions, or anions, are active, and when cationic agents are dissolved the positive ions, or cations, are active. Although fatty acids are anionic, they are widely used in non-metallic mineral floatation and, for the purpose of this report, have been considered as a fourth class.

There are many thousands of surfactants available, and the list is continually increasing and changing. The older, stable types are rapidly being replaced by biodegradables. For the purpose of floatation these can be narrowed into a comparatively small number of general types, with an even narrower grouping applicable to non-metallics. Reagents that are in more or less common use as floatation collectors have been included as well as newcomers.

The collectors used are listed below according to their activity, type, trade name, and general chemical name.

NON-IONIC, Ethanol

Igepal CTA	Alkyl phenoxy poly- (ethyleneoxy) ethanol
Rexol 25J	Nonyl phenol polyethoxy ethanol

ANIONIC, Petroleum sulphonate

Reagent 801	"Green acid"-type petroleum sulphonate
Petroflote 462	Sodium alkyl-aryl petroleum sulphonic acid
Leonal SA	Naphthalene sulphonic acid derivative

ANIONIC, Fatty acid sulphonate

Emcol 4510	Fatty acid aliphatic sulphonate
Sulphonated castor oil	Sulphonated castor oil (60% fats)
Prestabit oil V	Sulphonated fatty acids

ANIONIC, Alkyl sulphate

Duonol 80	Sodium octyl sulphate
Nutrapon WAC	Sodium lauryl sulphate
Duonol OS	Diethyl cyclohexylamine lauryl sulphate

ANIONIC, Sodium taurate

Igepon TE 42	Sodium-N-methyl-N-tallow acid taurate
Igepon T 33	Sodium-N-methyl-N-oleoyl taurate
Igepon TN 74	Sodium-N-methyl-N-palmitoyl taurate

CATIONIC, Primary amine

Adogen 170A	Technical tallow amine acetate
Armac C	Coco amine acetate
Armeen L-9	Primary beta amine

CATIONIC, Diamine

Duomac T	Tallow diamine di-acetate
Duomac C	Coco diamine di-acetate
Duomeen L-11	Beta diamine

CATIONIC, Tertiary amine

Nalcimine G 11	Hydroxyethyl alkyl imidazoline (glyoxalidine)
Armeen 12D	Lauryl amine
Armeen DLM 11	Beta tertiary amine

CATIONIC, Quaternary

Emcol E 607-40	N(lauroyl-colamino-formyl-methyl) pyridinium chloride
ARQUAD 12	n-alkyl trimethyl ammonium chloride
Retarder LA	Cetyl trimethyl ammonium bromide
Ammonyx T	Cetyl trimethyl benzyl ammonium chloride

FATTY ACID, Tall oil

Neofat 42-12	Tall oil base fatty acid
Actinol FA 2	Tall oil fatty acid

FATTY ACID, Oleic

Harfat 231	Oleic acid blend
Distilled oleic acid	Oleic acid

MODIFIERS INVESTIGATED

As pointed out in the previous section, floatation is effected by the action of a collector, causing the surface of a mineral to become hydrophobic. In many cases, however, it is necessary to use, as well, modifying agents to achieve this. Such agents simply aid in getting the collector onto the surface of the mineral to be floated. This action is called activation. On the other hand, a modifying agent may prevent a collector from getting onto the surface of unwanted minerals. This action is called depression. These are probably the most important functions of modifiers.

The regulation of pH is itself a form of modifying. As indicated earlier, all the experiments take place at three pH levels. The cleaning of surfaces, dispersion of ultra-fine solids, precipitation of dissolved salts, and other functions, are handled by modifying agents. Some agents serve more than one purpose - e. g., sodium carbonate may act as a dispersant, activator, depressant, or means of pH control. Metal ions are believed to alter the mineral surfaces by being adsorbed to these surfaces. Organic colloids are thought to blank off surfaces. Organic acids may aid in activation, depression, or cleaning surfaces.

The pH-controlling agents employed have been described under EXPERIMENTAL PROCEDURE. Other modifiers used in the experiments are: 1) three to provide ion resurfacing - FeSO_4 for iron, $\text{Al}_2(\text{SO}_4)_3$ for aluminum, and HF for fluorine; 2) two organic colloids to blank mineral surfaces - starch and dextrin; and 3) one organic acid - citric acid.

RESULTS

The object in the method of presenting the results is usability. Ready comparison of the results for individual minerals is necessary in order to facilitate selection of the liquid systems in which separations would be likely to take place. In this report, the estimations for each mineral have been condensed so that they will fit onto the front and back of a single sheet. Each sheet may be removed from the report so that it may be laid beside another, or so that two or more may be overlapped, for easier comparison.

For each mineral, floatation is estimated according to collectors on the front of a page, and according to modifiers on the back of a page. To make comparison as easy as possible, the floatability is depicted by four symbols - black for excellent, cross-hatched for good, stippled for fair, and blank for poor. Thus the darker areas, black and cross-hatched, generally indicate acceptable floatation, whereas the lighter areas, stippled and white, indicate unsatisfactory floatation at best.

In the initial recording of observations as described under EXPERIMENTAL PROCEDURE, the number of particles adhering to the bubble and the strength of the bond were indicated. Thus, 15G stood for about 15 particles picked up and firmly held by the bubble (good bond). If the record was 15F, then some or most of the particles could be dislodged by a light tapping on the bubble tube (fair bond). A record such as 3P would indicate 3 particles picked up and either dropping from the bubble after a moment or two or dropping after a light tap on the bubble tube (poor bond).













In assessing the results for this method of presentation, one has to use a form of weighted average. This consists of arbitrarily allotting the number 1 to poor bond, 2 to fair bond and 3 to good bond, then multiplying the number of particles by these numbers. The aggregate of all cases divided by the number of cases is then used to determine the average floatability. An average below 10 is considered to be poor, between 10 and 25 fair, 25 to 40 good, and above 40 excellent. In the occasional doubtful case between poor and fair, or between fair and good, floatability has been indicated by using both symbols. Results which differ greatly from the average have not been used in the calculation but are pointed out as exceptions.


































Results are presented for the various minerals in alphabetical order, and each sheet is dated so that, with subsequent extensions of the work, the latest and most up-to-date sheets will be retained.

RESPONSE TO COLLECTORS

ALBITE

KEY: Excellent Flotation  Fair Flotation 
 Good Flotation  Poor Flotation 

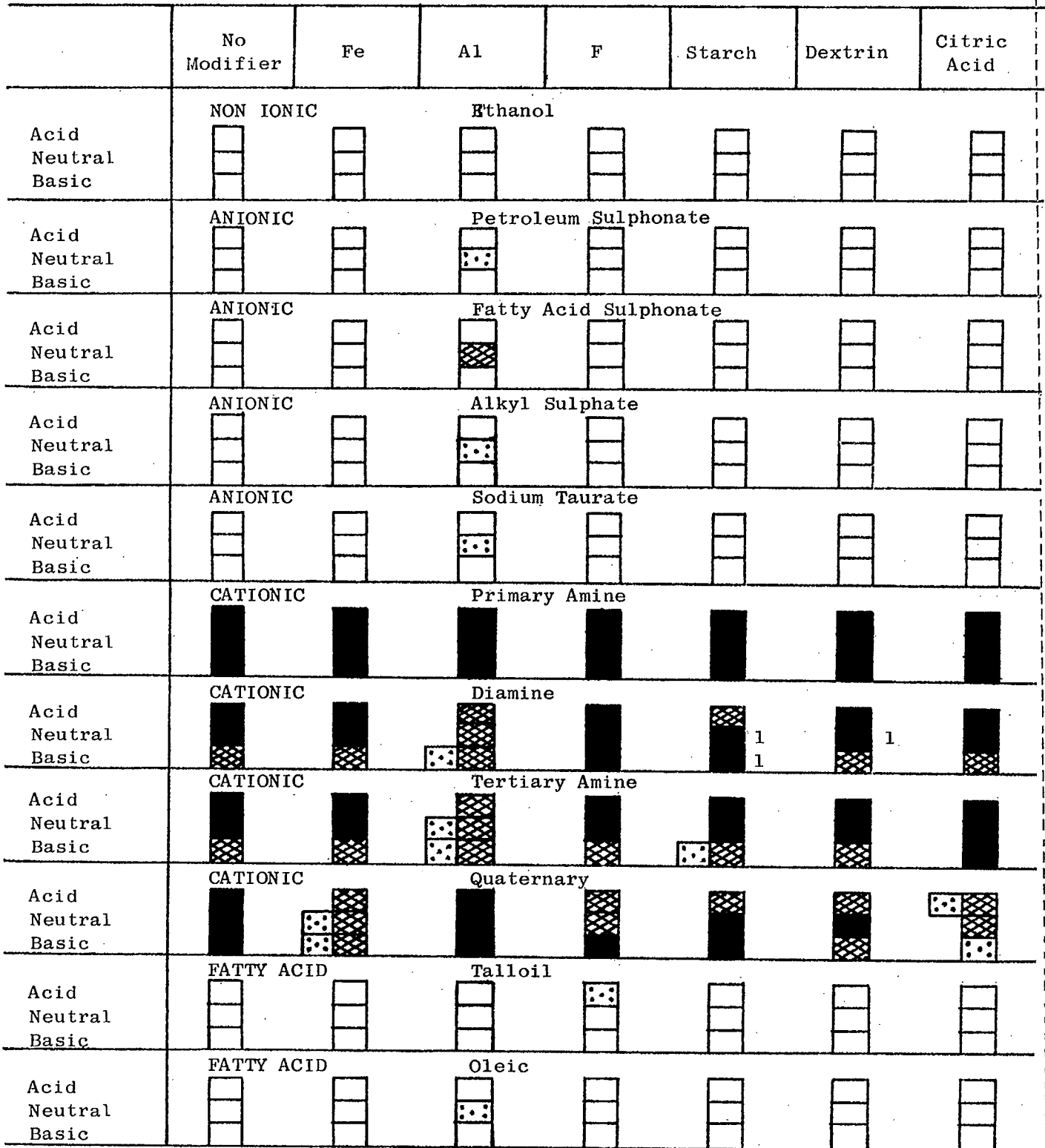
<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date ..October, 1968.....

ALBITE

EFFECT OF MODIFIERS
















































1. Poor flotation with Duomeen L-11

RESPONSE TO COLLECTORS

APATITE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

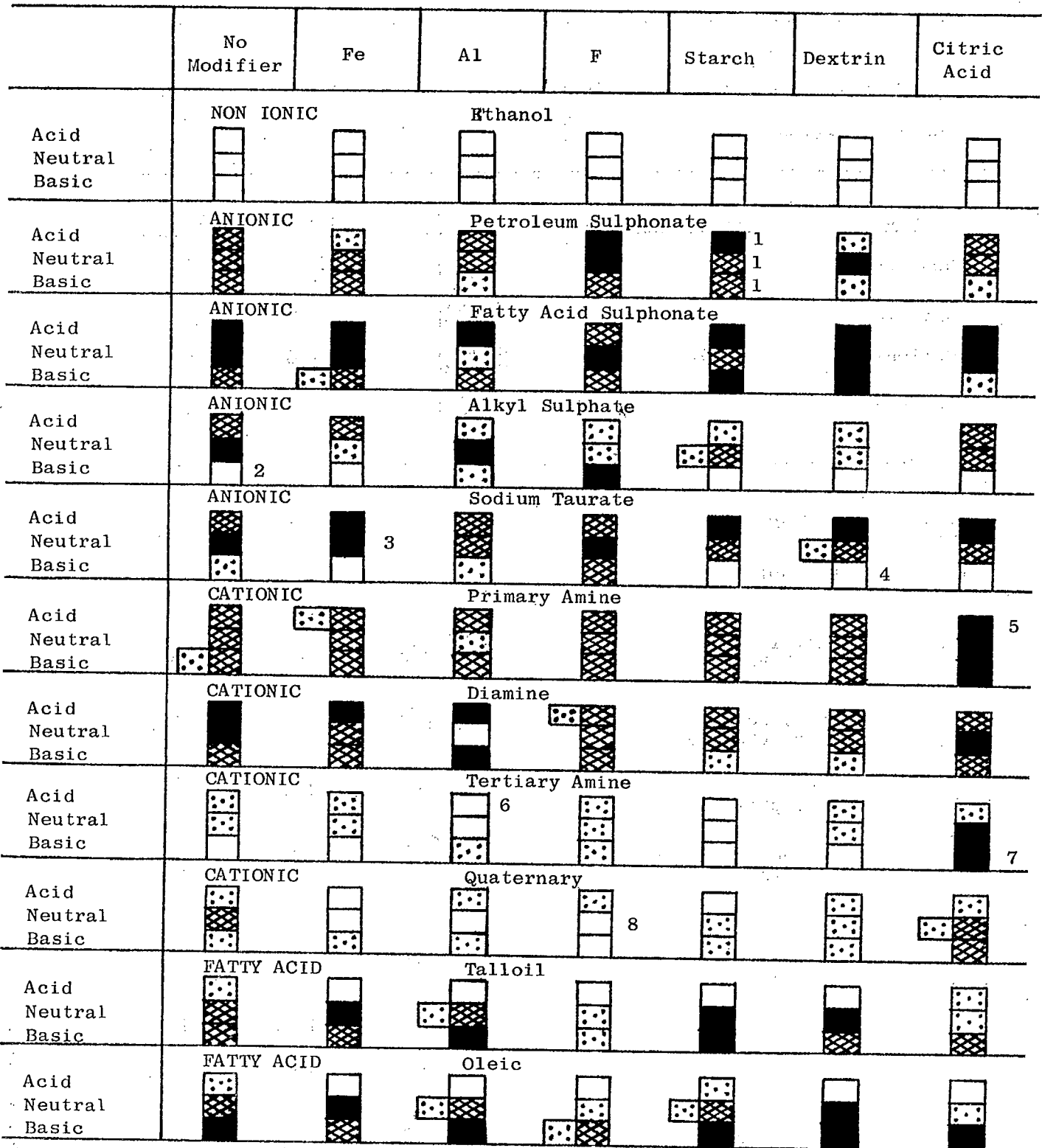
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"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date .October, 1968.....

APATITE

EFFECT OF MODIFIERS















- 1. Poor flotation with Leonal SA
- 2. Excellent flotation with Nutrapon WAC
- 3. Poor " " Igepon TE 42
- 4. Good " " " TE 42
- 5. Poor " " Armeen L-9
- 6. Good " " Nalcomine G 11
- 7. Poor " " " G 11
- 8. Excellent " " Emcol E 607-40


































Date October, 1968

RESPONSE TO COLLECTORS

BARITE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

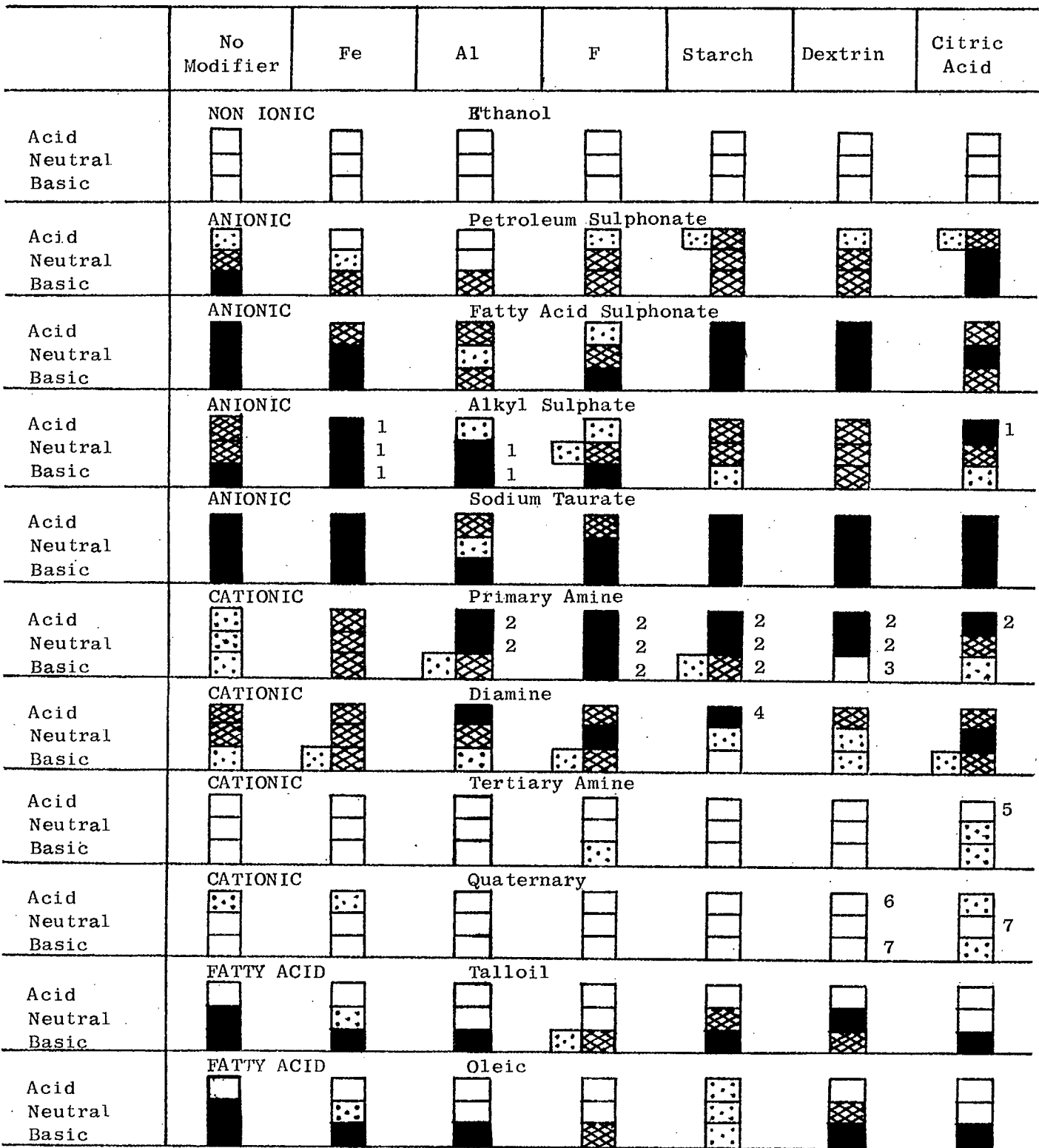
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"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date .. October, 1968

BARITE

EFFECT OF MODIFIERS















1. Poor flotation with Duponol 80
2. " " " Armeen L-9
3. Excellent " " Adogen 170 A
4. Poor " " Duomeen L-11
5. Excellent " " Nalcamine G-11
6. " " " Ammonyx T
7. " " " Emcol E 607-40


































Date .. October 1968 ..

RESPONSE TO COLLECTORS

BERYL

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
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"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date October, 1968

BERYL

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid, Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID		Talloil				
Acid Neutral Basic	FATTY ACID		Oleic				













1. Poor flotation with Prestabilt Oil V
2. Good " " Emcol 4510
3. Good " " Duponol 80
4. Poor " " " "
5. " " " Armeen L-9
6. " " " Duomac T
7. " " " Duomeen L-11
8. Good " " Nalcamine G-11
9. Poor " " " "
0. " " " Emcol E 607-40


































Date .. October, 1968.....

RESPONSE TO COLLECTORS

BIOTITE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
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"	Diamine	3			
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"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date: October, 1968

BIOTITE

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid	NON IONIC		Ethanol				
Neutral							
Basic							
Acid	ANIONIC		Petroleum Sulphonate				
Neutral							
Basic							
Acid	ANIONIC		Fatty Acid Sulphonate				
Neutral							
Basic							
Acid	ANIONIC		Alkyl Sulphate				
Neutral							
Basic							
Acid	ANIONIC		Sodium Taurate				
Neutral							
Basic							
Acid	CATIONIC		Primary Amine				
Neutral							
Basic							
Acid	CATIONIC		Diamine				
Neutral							
Basic							
Acid	CATIONIC		Tertiary Amine				
Neutral							
Basic							
Acid	CATIONIC		Quaternary				
Neutral							
Basic							
Acid	FATTY ACID		Talloil				
Neutral							
Basic							
Acid	FATTY ACID		Oleic				
Neutral							
Basic							







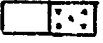





- 1. Poor flotation with Reagent 801
- 2. Good " " Igepon TE 42
- 3. Poor " " Armeen L-9
- 4. " " " Retarder LA


































Date October 1968

RESPONSE TO COLLECTORS

CALCITE

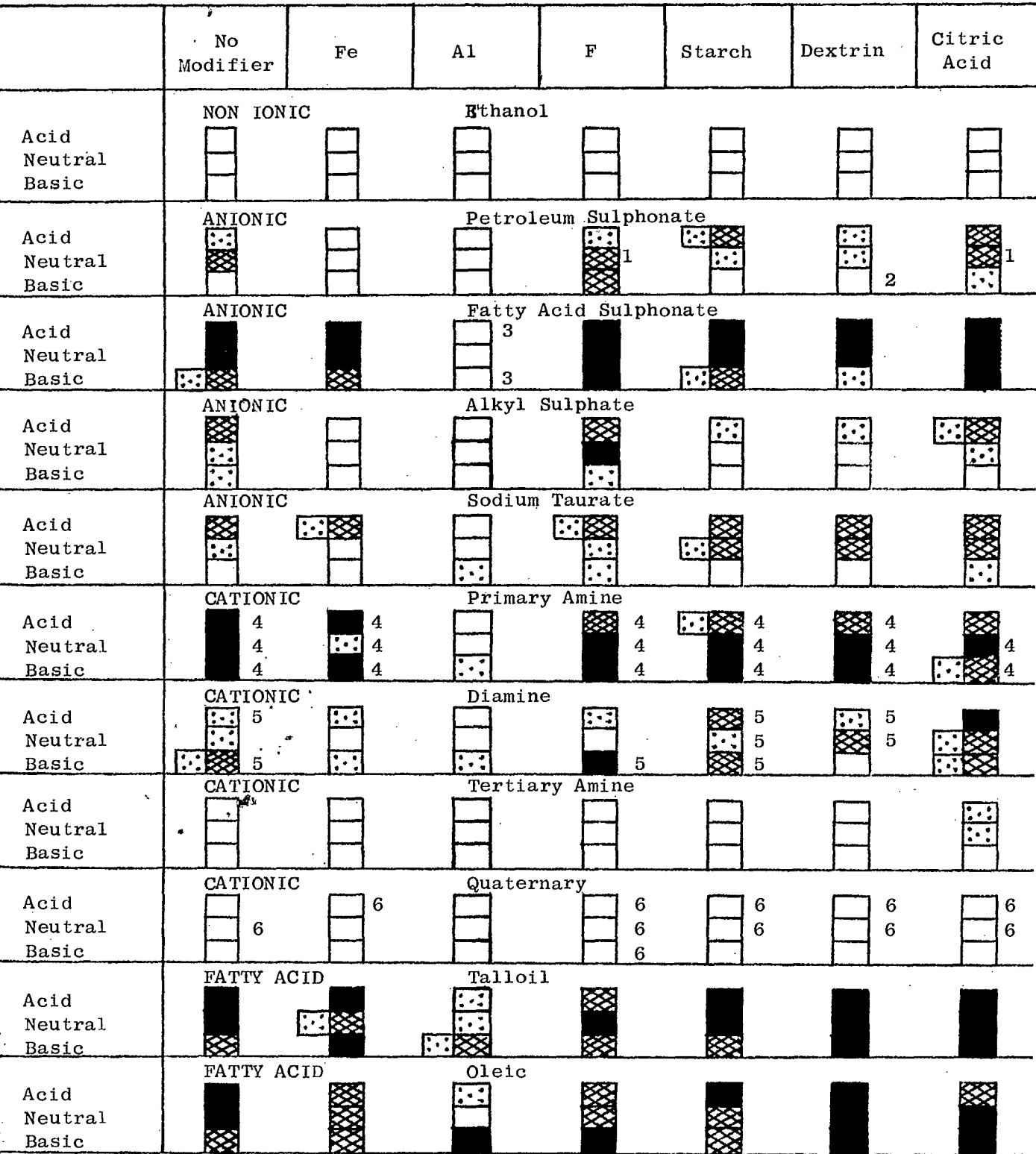
KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

CALCITE

EFFECT OF MODIFIERS
















































- 1. Poor flotation with Leonal SA
- 2. Good " " Petroflote 462
- 3. " " " Duponol 80
- 4. Poor " " Armeen L-9
- 5. " " " Duomeen L-11
- 6. Excellent " " Emcol E 607-40

Date October 1968

RESPONSE TO COLLECTORS

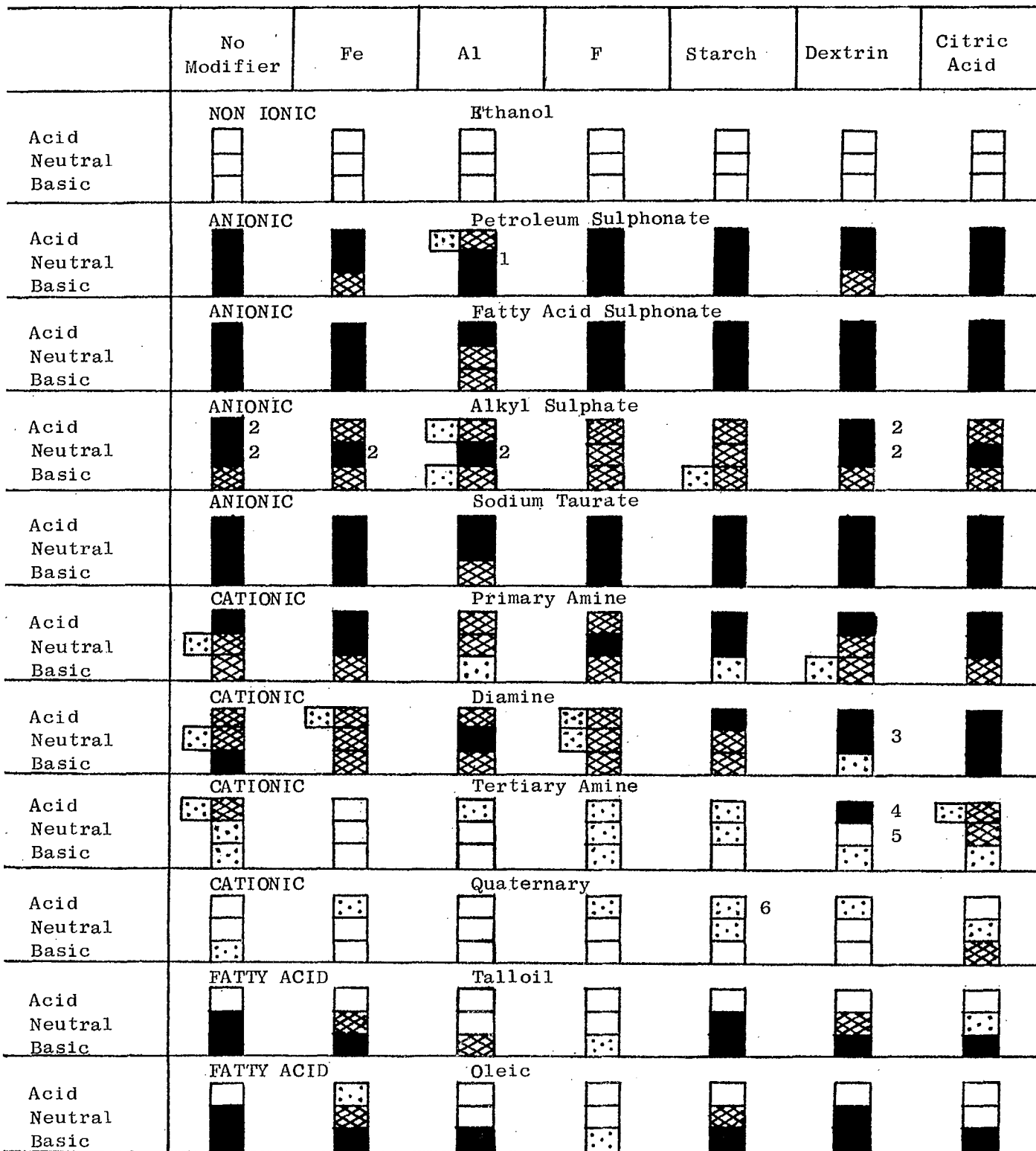
KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

CELESTITE

EFFECT OF MODIFIERS




- 1. Poor flotation with Leonal SA
- 2. " " " Duponol 80
- 3. " " " Duomeen L-11
- 4. " " " Armeen DLM-11
- 5. Excellent " " Armeen 12D
- 6. " " " Emcol E 607-40



































Date .. October, 1968

RESPONSE TO COLLECTORS

CORUNDUM

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3	 		
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date October, 1968.....

CORUNDUM

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				1 1
Acid Neutral Basic	ANIONIC	2	Sodium Taurate	3	2		
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID	4	Talloil	4	4	4	4
Acid Neutral Basic	FATTY ACIL	4	Oleic	4	4	4	4













- 1. Poor flotation with Duponol OS
- 2. " " " Igepon TN-74
- 3. Excellent " " Igepon TE-42
- 4. Response inconsistent (poor to excellent)


































Date ... October, 1968

RESPONSE TO COLLECTORS

FLUORITE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid.</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date October, 1968.....

FLUORITE

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID		Talloil				
Acid Neutral Basic	FATTY ACID		Oleic				













- 1. Excellent flotation with Nutrapon WAC
- 2. Poor " " Duponol 80
- 3. Excellent " " Igepon TE-42
- 4. Poor " " Armeen L-9
- 5. Good " " Nalcamine G-11


































Date .. October 1968

RESPONSE TO COLLECTORS

GARNET

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date October, 1968

GARNET

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC	Ethanol					
Acid Neutral Basic	ANIONIC	Petroleum Sulphonate					
Acid Neutral Basic	ANIONIC	Fatty Acid Sulphonate					
Acid Neutral Basic	ANIONIC	Alkyl Sulphate					
Acid Neutral Basic	ANIONIC	Sodium Taurate					
Acid Neutral Basic	CATIONIC	Primary Amine					
Acid Neutral Basic	CATIONIC	Diamine					
Acid Neutral Basic	CATIONIC	Tertiary Amine					
Acid Neutral Basic	CATIONIC	Quaternary					
Acid Neutral Basic	FATTY ACID	Talloil					
Acid Neutral Basic	FATTY ACID	Oleic					













1. Excellent flotation with Prestabilt Oil V
2. " " " Emcol 4510
3. " " " Igepon TE-42
4. " " " Duomac T
5. Poor " " Duomeen L-11
6. Response Inconsistent (Poor to Excellent)


































Date ..October 1968

RESPONSE TO COLLECTORS

GYPSUM

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date .. October, 1968

GYPSUM

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid	NON IONIC		Ethanol				
Neutral							
Basic							
Acid	ANIONIC		Petroleum Sulphonate				
Neutral							
Basic							
Acid	ANIONIC		Fatty Acid Sulphonate				
Neutral							
Basic							
Acid	ANIONIC		Alkyl Sulphate				
Neutral							
Basic							
Acid	ANIONIC		Sodium Taurate				
Neutral							
Basic							
Acid	CATIONIC		Primary Amine				
Neutral							
Basic							
Acid	CATIONIC		Diamine				
Neutral							
Basic							
Acid	CATIONIC		Tertiary Amine				
Neutral							
Basic							
Acid	CATIONIC		Quaternary				
Neutral							
Basic							
Acid	FATTY ACID		Talloil				
Neutral							
Basic							
Acid	FATTY ACID		Oleic				
Neutral							
Basic							













1. Excellent flotation with Reagent 801
2. " " " Emcol 4510
3. Poor " " Prestabil Oil V
4. Excellent " " Duponol 80
5. Poor " " Armeen L-9
6. " " " Duomac C
7. Excellent " " Duomac T
8. " " " Duomeen L-11
9. " " " Nalcamine G-11
10. " " " Emcol E 607-40


































Date October 1968

RESPONSE TO COLLECTORS

HORNBLLENDE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date December, 1968

HORNBLENDE

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC	Ethanol					
Acid Neutral Basic	ANIONIC	Petroleum Sulphonate					
Acid Neutral Basic	ANIONIC	Fatty Acid Sulphonate					
Acid Neutral Basic	ANIONIC	Alkyl Sulphate					
Acid Neutral Basic	ANIONIC	Sodium Taurate					
Acid Neutral Basic	CATIONIC	Primary Amine					
Acid Neutral Basic	CATIONIC	Diamine					
Acid Neutral Basic	CATIONIC	Tertiary Amine					
Acid Neutral Basic	CATIONIC	Quaternary					
Acid Neutral Basic	FATTY ACID	Talloil					
Acid Neutral Basic	FATTY ACID	Oleic					












- 1 Poor flotation with Reagent 801
- 2 " " " Leonal SA
- 3 Excellent " " Emcol 4510
- 4 Poor " " Igepon TN-74
- 5 Excellent " " Igepon TE-42
- 6 Poor " " Duomeen L-11
- 7 Excellent " " Duomac T
- 8 " " " Nalcamine G-11
- 9 Response inconsistent (Poor to excellent)


































Date . December . 1968

RESPONSE TO COLLECTORS

KYANITE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date December, 1968.....

KYANITE

EFFECT OF MODIFIERS








	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID		Tallicoil				
Acid Neutral Basic	FATTY ACID		Oleic				


































1. Excellent flotation with Adogen 170A
2. " " " Duomac T
3. Poor " " Duomeen L-11
4. Excellent " " ARQUAD 12

Date December 1968

RESPONSE TO COLLECTORS

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

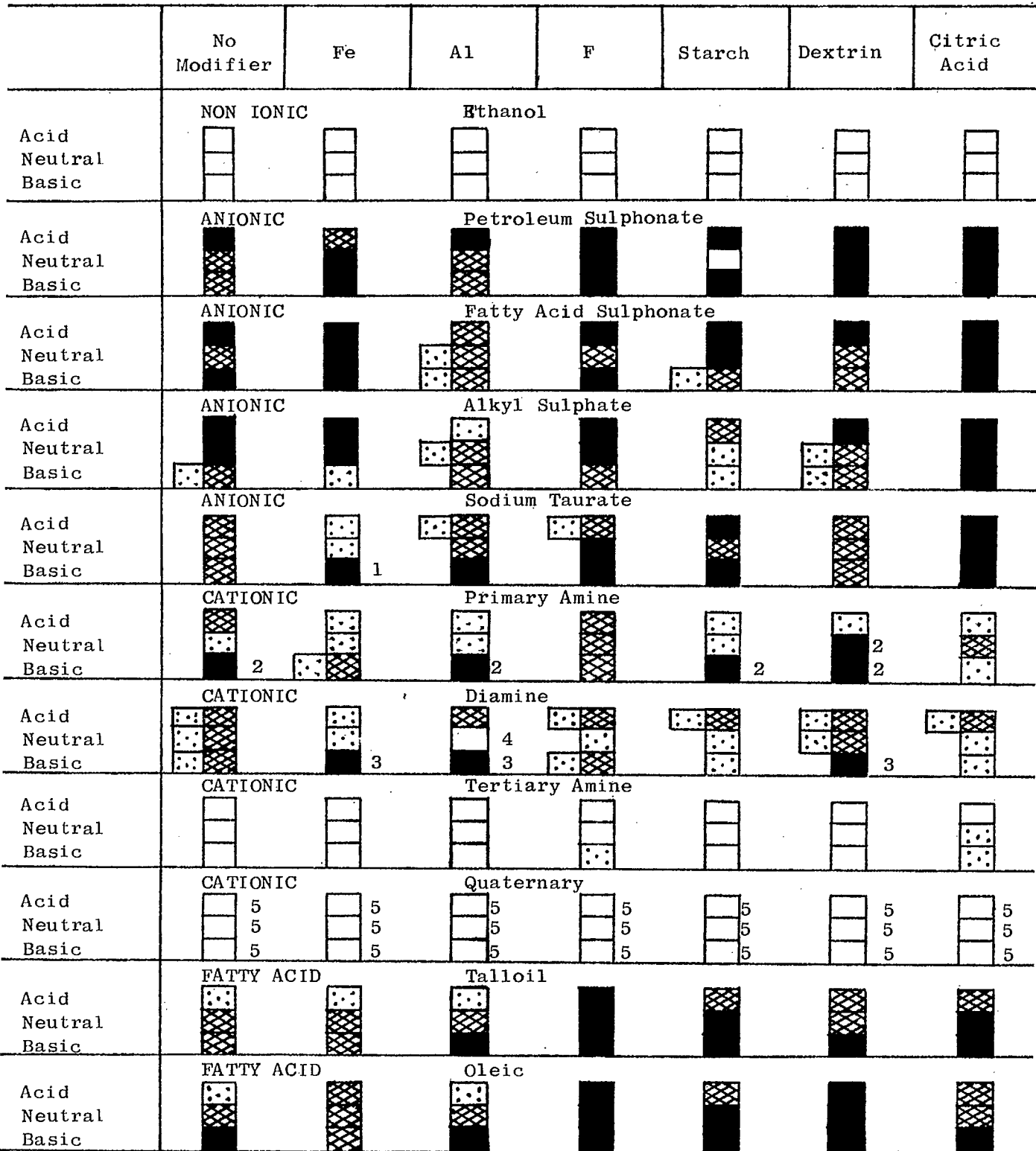
<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date , December, 1968.....

MAGNESITE

EFFECT OF MODIFIERS
















































- 1. Poor flotation with Igepon TE-42
- 2, " " " Armeen L-9
- 3. " " " Duomeen L-11
- 4. Excellent " " Duomac T
- 5. " " " Emcol E 607-40

Date, December, 1968

RESPONSE TO COLLECTORS

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2 ✓			
Anionic	12 ✓			
Cationic	13			
Fatty acid	4 ✓			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate ✓	3			
"	Alkyl sulphate ✓	3			
"	Sodium taurate ✓	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil ✓	2			
"	Oleic ✓	2			

MUSCOVITE












EFFECT OF MODIFIERS


































	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID		Talloil				
Acid Neutral Basic	FATTY ACID		Oleic				

- 1. Good flotation with Duponol 80
- 2. Poor " " Adogen 170 A
- 3. " " " Duomeen L-11
- 4. " " " Duomac T

RESPONSE TO COLLECTORS

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date December, 1968

ORTHOCLASE

EFFECT OF MODIFIERS













	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				1 1
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate	2			
Acid Neutral Basic	ANIONIC	3	Alkyl Sulphate	4			
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC	5 5	Primary Amine	6 5			
Acid Neutral Basic	CATIONIC	7 7 7	Diamine			7	
Acid Neutral Basic	CATIONIC		Tertiary Amine		8		
Acid Neutral Basic	CATIONIC	9	Quaternary		10	10	
Acid Neutral Basic	FATTY ACID		Talloil				
Acid Neutral Basic	FATTY ACID		Oleic				


































- 1. Fair flotation with Rexol 25 J
- 2. Excellent " " Sulphonated Castor Oil
- 3. " " " Duponol 80
- 4. " " " Duponol OS
- 5. Poor " " Adogen 170A
- 6. Excellent " " Armac C
- 7. Poor " " Duomac T
- 8. Good " " Nalcamine G-11
- 9. " " " Emcol E 607-40
- 10. Poor " " Ammonyx T

Date ... December, 1968

RESPONSE TO COLLECTORS

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			 ↙
Anionic	12			 ↙
Cationic	13			 ↙
Fatty acid	4			 ↙

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			 ↙
Anionic	Petroleum sulphonate	3			 ↙
"	Fatty acid sulphonate	3			 ↙
"	Alkyl sulphate	3			 ↙
"	Sodium taurate	3			 ↙
Cationic	Primary amine	3	 ↙		
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2	 ↙		
"	Oleic	2	 ↙		

Date December, 1968.....

QUARTZ

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid X Neutral Basic	NON IONIC		Ethanol				
Acid X Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid X Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid X Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid X Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid X Neutral Basic	FATTY ACID		Talmoil				
Acid X Neutral Basic	FATTY ACID		Oleic				













- 1. Poor flotation with Duomac T
- 2. Good " " Nalcamine G-11
- 3. Poor " " ARQUAD 12


































Date December 1968

RESPONSE TO COLLECTORS

SPODUMENE

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date December, 1968

SPODUMENE

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate		2		2
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID		Talioil				
Acid Neutral Basic	FATTY ACID		Oleic				













- 1. Good flotation with Reagent 801
- 2. Fair " " Emcol 4150
- 3. Good " " Duponol 80
- 4. Excellent " " Duomac C
- 5. Poor " " Duomac T
- 6. " " Emcol E 607-40


































Date December 1968

RESPONSE TO COLLECTORS

TALC

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

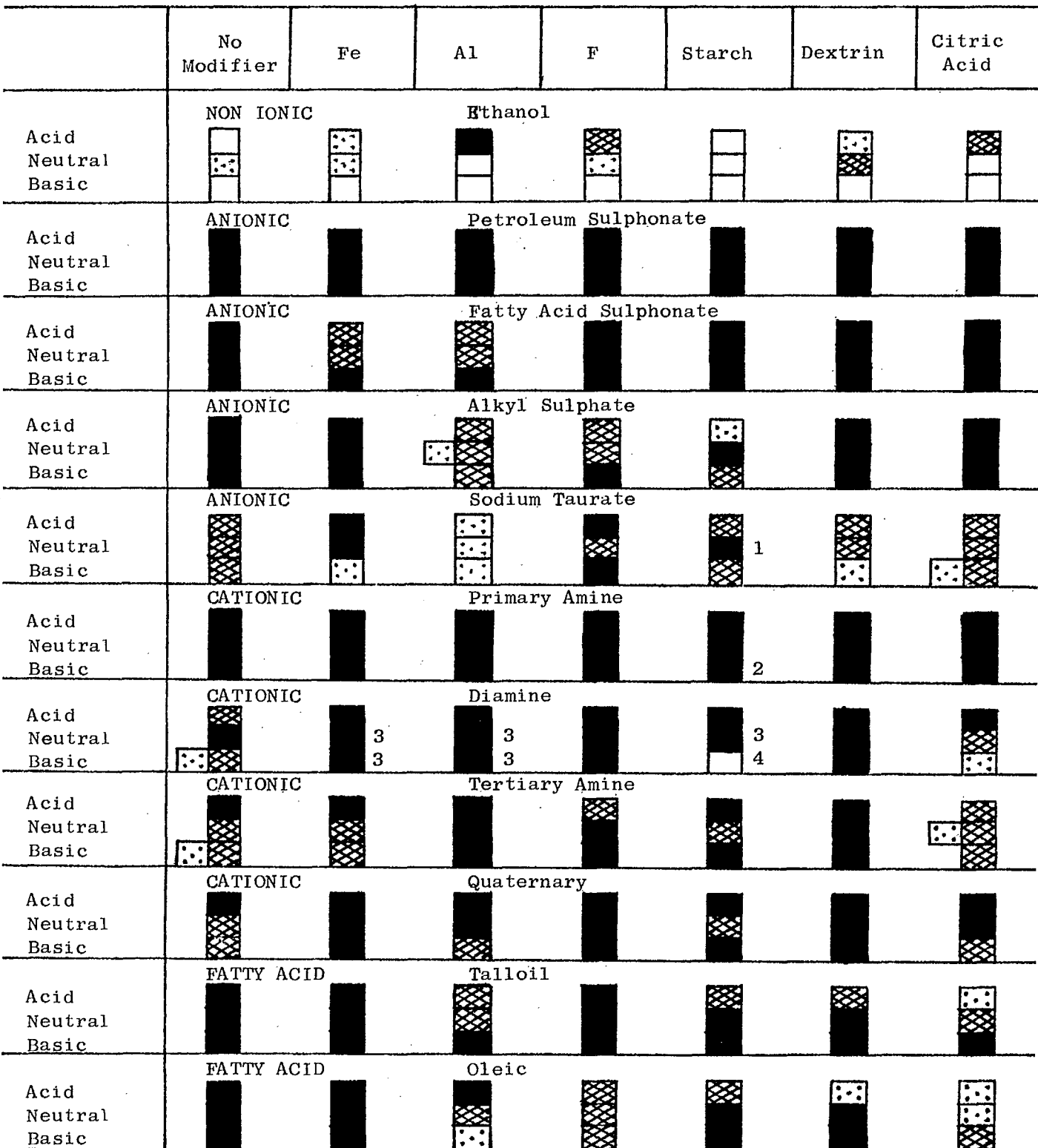
<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date December, 1968.....

TALC

EFFECT OF MODIFIERS
















































- 1. Poor flotation with Igepon TN 74
- 2. " " " Armac C
- 3. " " " Duomeen L-11
- 4. Excellent " " Duomac T

Date December 1968

RESPONSE TO COLLECTORS

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

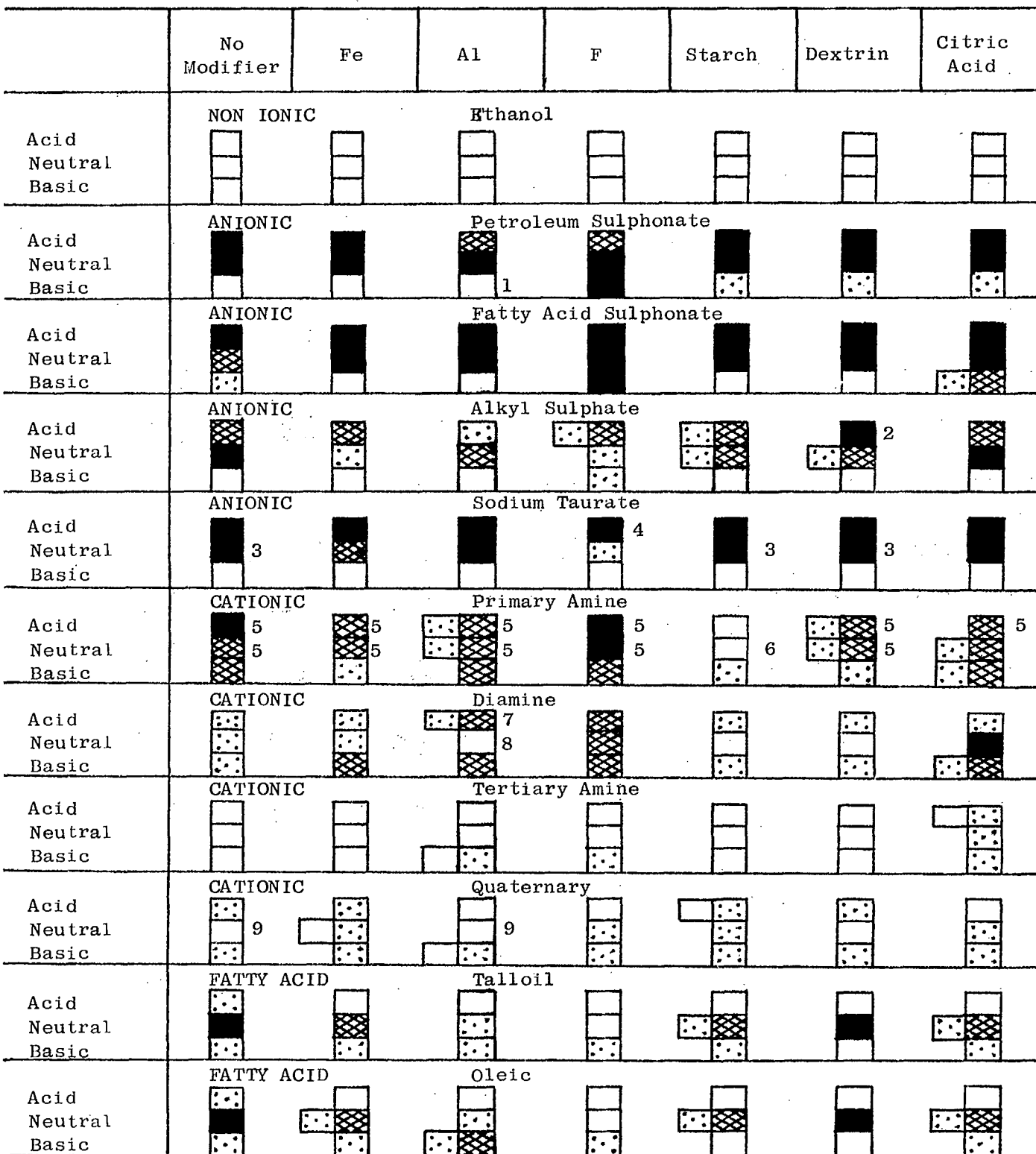
<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talloil	2			
"	Oleic	2			

Date December, 1968

TOPAZ

EFFECT OF MODIFIERS
















































1. Good flotation with Leonal SA
2. Poor " " Duponol 80
3. " " " Igepon TN-74
4. " " " Igepon TE-42
5. " " " Armeen L-9
6. Good " " Adogen 170 A
7. Poor " " Duomac C
8. Good " " Duomac T
9. " " " Emcol E 607-40

Date December .1968.

RESPONSE TO COLLECTORS

KEY:	Excellent Flotation		Fair Flotation	
	Good Flotation		Poor Flotation	

<u>CLASS</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	2			
Anionic	12			
Cationic	13			
Fatty acid	4			

<u>Class</u>	<u>TYPE</u>	<u>No. Tested</u>	<u>Acid</u>	<u>Neutral</u>	<u>Basic</u>
Non-ionic	Ethanol	2			
Anionic	Petroleum sulphonate	3			
"	Fatty acid sulphonate	3			
"	Alkyl sulphate	3			
"	Sodium taurate	3			
Cationic	Primary amine	3			
"	Diamine	3			
"	Tertiary amine	3			
"	Quaternary	4			
Fatty acid	Talmoil	2			
"	Oleic	2			

Date December, 1968

VERMICULITE

EFFECT OF MODIFIERS

	No Modifier	Fe	Al	F	Starch	Dextrin	Citric Acid
Acid Neutral Basic	NON IONIC		Ethanol				
Acid Neutral Basic	ANIONIC		Petroleum Sulphonate				
Acid Neutral Basic	ANIONIC		Fatty Acid Sulphonate				
Acid Neutral Basic	ANIONIC		Alkyl Sulphate				
Acid Neutral Basic	ANIONIC		Sodium Taurate				
Acid Neutral Basic	CATIONIC		Primary Amine				
Acid Neutral Basic	CATIONIC		Diamine				
Acid Neutral Basic	CATIONIC		Tertiary Amine				
Acid Neutral Basic	CATIONIC		Quaternary				
Acid Neutral Basic	FATTY ACID		Talloil				
Acid Neutral Basic	FATTY ACID		Oleic				

- 1. Poor flotation with Duomeen L-11
- 2. Excellent flotation with Duomac T
- 3. Poor flotation with Duomac T

Date December 1968

CONCLUSION

The method of presenting results provides a ready comparison of the effect of similar liquid systems on different minerals, and indicates areas for possible selective floatation.

ACKNOWLEDGEMENT

All of the individual experiments (approximately 14,000) and observations were made by J.H. Colborne of the Industrial Minerals Milling Section. The success of the project is, in large measure, due to his careful and thorough workmanship.

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RAW/cw

