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Cover Picture

MOUNTAIN LAKE

The vertical aerial photograph is of an area two miles square in the southwestern part of the Arbuckle Mountains, just north of the village of Woodford in Carter County. Mountain Lake, impounded behind a concrete dam across Hickory Creek, supplies water for Ardmore.

The area shown is a small part of the south flank of the Arbuckle anticline, one of the major structural features of the Arbuckle Mountains. The rock strata dip southwestward at angles of 25 to 40 degrees. Exposed is a 3,000-foot sequence of sedimentary rocks which range in age from Early Ordovician to Mississippian.

The oldest rocks are shown in the upper right corner. They are thin-bedded carbonates of the West Spring Creek Formation (Ow) at the top of the Arbuckle Group. Overlying formations of the Simpson Group (Osp) consist of limestones (light-colored beds), shales (gray), and sandstones (tree-covered). Massive limestone of the Bromide Formation at the top of the group serves as the foundation of the dam of Mountain Lake. The thick white band above is Viola Limestone (Ov), which is succeeded upward by Sylvan Shale (Os) in a tree-covered valley. Limestones of the Hunton Group (DSh) crop out in a treeless double ridge. They are overlain by dark shales and interbedded chert of the Woodford Formation (MDw), supporting a thick growth of trees. Sycamore Limestone (Ms) crops out in a light-colored ridge, and the youngest beds are those of the Caney Shale (Mc).

Small-scale faults, resulting from minor adjustments on the flank of the broadly folded Arbuckle anticline, can be seen at several localities on the photograph. One of the more prominent is just beyond the west arm of Mountain Lake, cutting diagonally across strike and offsetting basal Viola and uppermost Simpson strata. At least eight smaller faults are apparent in the light-colored band of limestones on which the letter symbol Osp has been placed. This limestone is a conspicuous lithologic unit in the upper part of the Oil Creek Formation, and readily shows the faults by offsetting relations and by local changes in the strike of the faulted beds.

W. E. H.

CIPW Flow Chart

Kenneth S. Johnson

In 1902, Cross, Iddings, Pirsson, and Washington published a method of classifying igneous rocks on the basis of chemical composition. The system is commonly referred to as the CIPW classification. Based on the assumption that the chemical composition of a rock is one of its more fundamental characteristics, the CIPW system enables one to assign all of the major oxides given in a chemical analysis to a hypothetical set of mineral molecules. A statement of the calculated weight percentages of the mineral molecules is called the norm of a rock. The norm in many cases differs from the mode, which is expressed as the weight percentages of the minerals actually present.

The major divisions of the classification are based upon the norm, with further subdivisions based upon the relative molar abundance of several oxides. The final numerical classification may be used for rapid comparison of the norms of many igneous rocks.

Complete details of the calculations and classification were given in publications by the original authors (Cross and others, 1902, 1903) and by Washington (1917). A condensed and slightly modified version was presented by Johannsen (1931, p. 83-99).

Among the factors which have limited the more widespread application of the CIPW system is the time element. Calculating the norm and classifying a single igneous rock take from one to several hours. A computer can perform the same operations in less than ten seconds. It is possible to punch the input-data cards and to classify 45 igneous rocks completely in one hour, thereby removing one of the objectionable features of the CIPW classification.

Using the modified version published by Johannsen, the present writer made two flow charts of the classification. The generalized flow chart (fig. 1) indicates the major steps, and the detailed flow chart (figs. 2a-h) shows the precise operations performed in the CIPW system. The flow charts may be used in writing a program for a computer or, by eliminating those steps dealing specifically with computer operations, they may be used as a guide in making hand calculations.

Table I.—Input Data for CIPW Classification

(1) Weight percentages of:

SiO_2	SO_3	P_2O_5
Al_2O_3	S	F
ZrO_2	CO_2	NiO
K_2O	Fe_2O_3	MnO
Na_2O	FeO	MgO
CaO	Cr_2O_3	BaO
Cl	TiO_2	SrO

(2) Presence or absence of:
- modal hauynite
- modal cancrinite
- modal calcite

(3) Is calcite primary or secondary?

GENERALIZED FLOW CHART

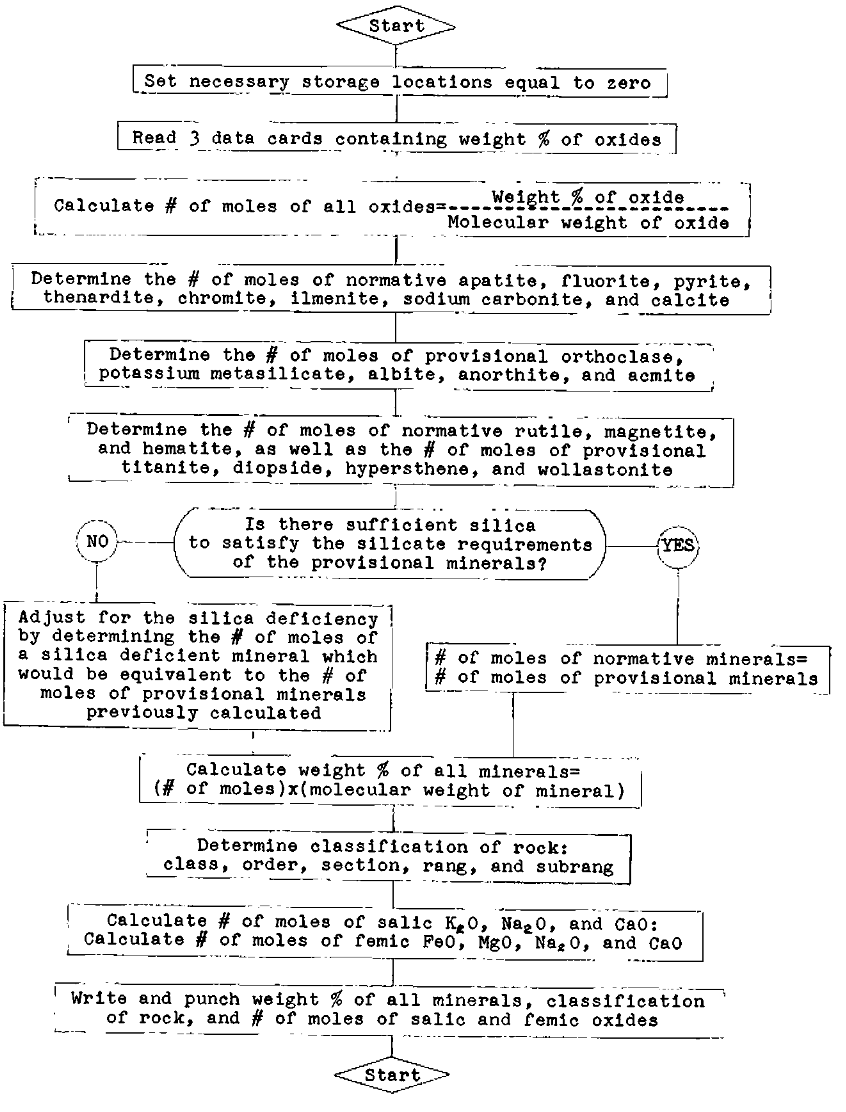


Figure 1.

From the detailed flow chart the writer designed a program which was satisfactorily tested on the IBM 650 Data Processing System at the computer laboratory of The University of Oklahoma. The problem was originally suggested by Dr. Hugh E. Hunter, and both he and Dr. Clifford A. Merritt assisted in writing and testing the program.

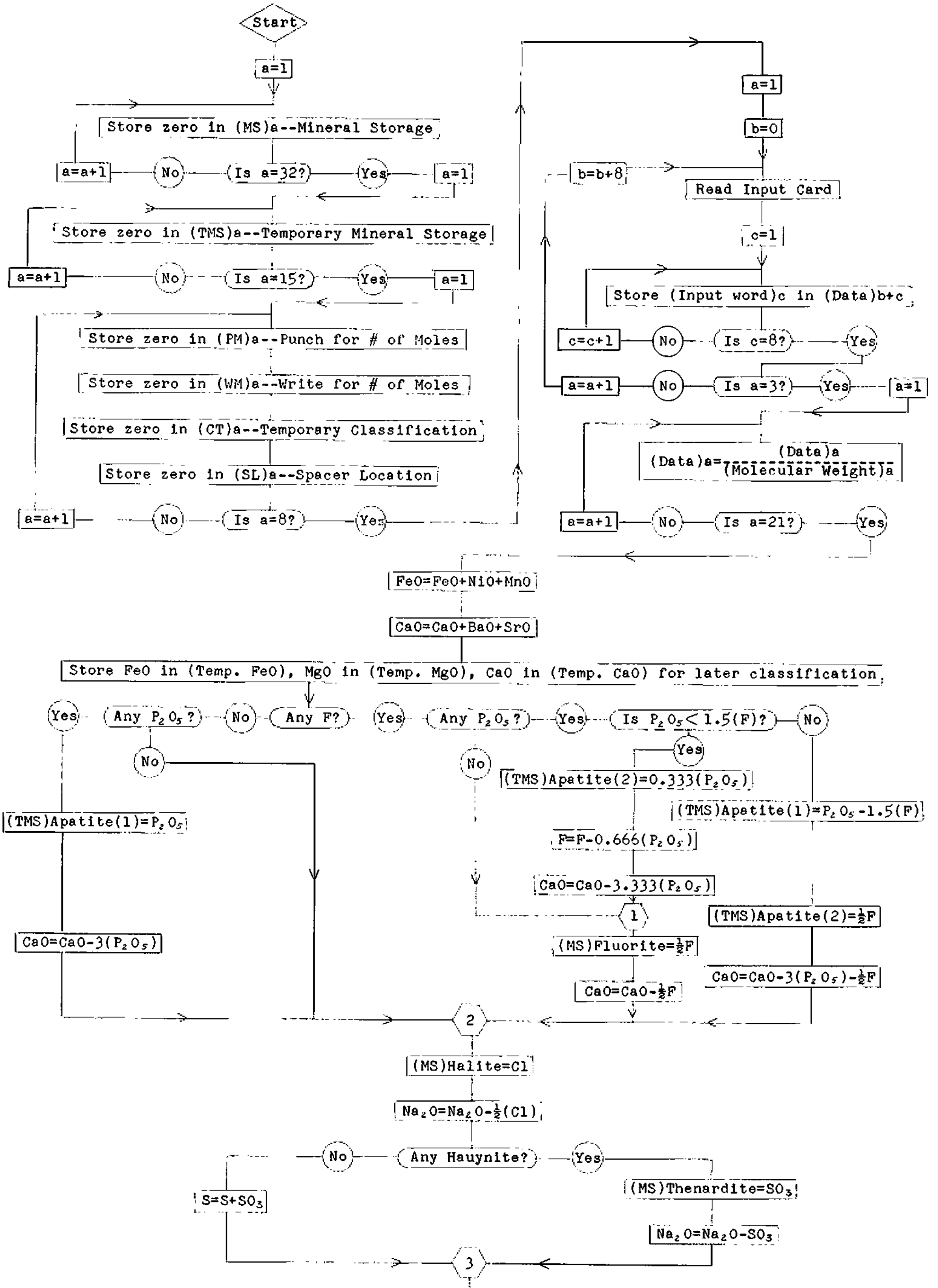
To test the accuracy of the computer program, about 40 chemical analyses of igneous rocks presented by Washington (1917) were used in calculating norms and classifications on the IBM 650. The computer-calculated norms were then compared with the hand-calculated norms of Washington. Most of the computer-calculated norm values were within a few tenths of one percent of those determined by hand (table III). The source of these insignificant variations is the higher degree of accuracy with which the computer performs mathematical operations. Discrepancies of more than one percent were found to be due to errors in punching the input-data cards, incorrect hand calculations, or minor differences in the method of calculation (e. g., amounts less than 0.002 mole of an oxide were neglected by Washington but are included in the programmed calculations).

(Continued on page 154)

TABLE II.—CHEMICAL AND MODAL INPUT DATA OF TWO IGNEOUS ROCKS USED TO TEST PROGRAM

OXIDE	Granite[1] WEIGHT %	Microgabbro[2] WEIGHT %
SiO_2	71.08	43.07
Al_2O_3	15.90	14.14
ZrO_2	0.08	
K_2O	4.08	2.70
Na_2O	3.54	4.60
CaO	2.60	12.26
Cl	0.02	
Fe_2O_3	0.62	3.47
FeO	1.31	7.21
TiO_2	0.22	2.00
P_2O_5	0.10	0.40
MnO	0.15	
MgO	0.54	8.55
BaO	0.04	
SrO	0.02	
Li_2O	Trace	
H_2O+	0.30	1.64
Total	100.60	100.04
	No hauynite No cancrinite No calcite	No hauynite No cancrinite No calcite

[1]El Capitan, Yosemite Valley, Calif. (Washington, 1917, p. 184).
[2]Coral Island, Los Islands, French Guinea (Washington, 1917, p. 698).



Start
a=1
Store zero in (MS)a--Mineral Storage
a=a+1
No
Is a=32?
Yes
a=1
Store zero in (TMS)a--Temporary Mineral Storage
a=a+1
No
Is a=15?
Yes
a=1
Store zero in (PM)a--Punch for # of Moles
Store zero in (WM)a--Write for # of Moles
Store zero in (CT)a--Temporary Classification
Store zero in (SL)a--Spacer Location
a=a+1
No
Is a=8?
Yes
a=1
b=0
b=b+8
Read Input Card
c=1
Store (Input word)c in (Data)b+c
c=c+1
No
Is c=8?
Yes
a=a+1
No
Is a=3?
Yes
a=1
(Data)a=(Data)a/(Molecular Weight)a
a=a+1
No
Is a=21?
Yes
FeO=FeO+NiO+MnO
CaO=CaO+BaO+SrO
Store FeO in (Temp. FeO), MgO in (Temp. MgO), CaO in (Temp. CaO) for later classification
Yes
Any P2O5?
No
Any F?
Yes
Any P2O5?
Yes
Is P2O5 < 1.5(F)?
No
Yes
No
No
(TMS)Apatite(2)=0.333(P2O5)
(TMS)Apatite(1)=P2O5-1.5(F)
(TMS)Apatite(1)=P2O5
F=F-0.666(P2O5)
CaO=CaO-3.333(P2O5)
1
(TMS)Apatite(2)=½F
CaO=CaO-3(P2O5)
(MS)Fluorite=½F
CaO=CaO-3(P2O5)-½F
CaO=CaO-½F
2
(MS)Halite=Cl
Na2O=Na2O-½(Cl)
No
Any Haunyite?
Yes
(MS)Thenardite=SO3
S=S+SO3
Na2O=Na2O-SO3
3

Figure 2a.

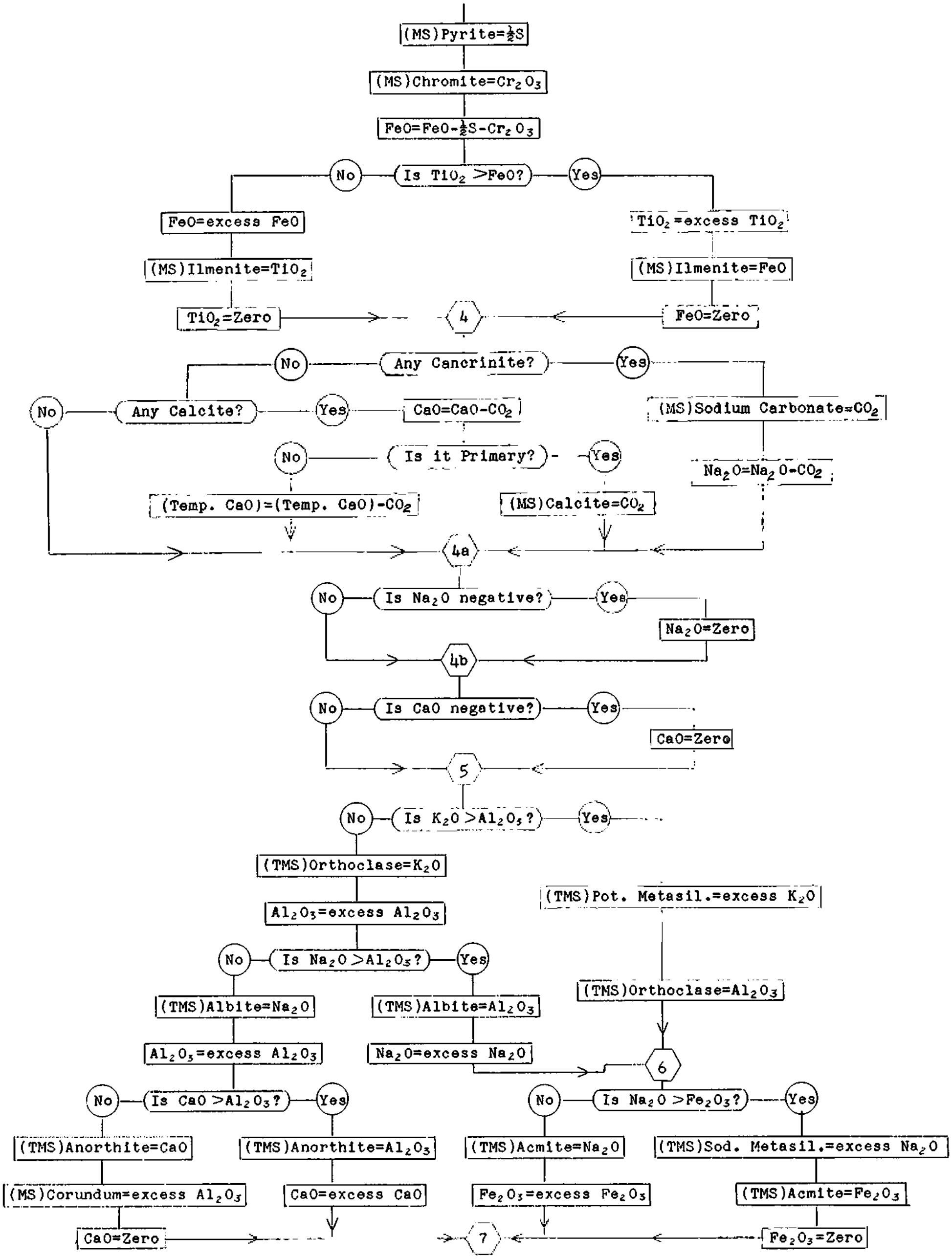

(MS)Pyrite=½S
(MS)Chromite=Cr_2O_3
FeO=FeO-½S-Cr_2O_3
Is TiO_2 >FeO?
No
Yes
FeO=excess FeO
(MS)Ilmenite=TiO_2
TiO_2=Zero
TiO_2=excess TiO_2
(MS)Ilmenite=FeO
FeO=Zero
4
Any Cancrinite?
Any Calcite?
CaO=CaO-CO_2
(MS)Sodium Carbonate=CO_2
Is it Primary?
Na_2O=Na_2O-CO_2
(Temp. CaO)=(Temp. CaO)-CO_2
(MS)Calcite=CO_2
4a
Is Na_2O negative?
Na_2O=Zero
4b
Is CaO negative?
CaO=Zero
5
Is K_2O >Al_2O_3?
(TMS)Orthoclase=K_2O
Al_2O_3=excess Al_2O_3
(TMS)Pot. Metasil.=excess K_2O
Is Na_2O >Al_2O_3?
(TMS)Orthoclase=Al_2O_3
(TMS)Albite=Na_2O
(TMS)Albite=Al_2O_3
Al_2O_3=excess Al_2O_3
Na_2O=excess Na_2O
6
Is CaO >Al_2O_3?
Is Na_2O >Fe_2O_3?
(TMS)Anorthite=CaO
(TMS)Anorthite=Al_2O_3
(TMS)Acmite=Na_2O
(TMS)Sod. Metasil.=excess Na_2O
(MS)Corundum=excess Al_2O_3
CaO=excess CaO
Fe_2O_3=excess Fe_2O_3
(TMS)Acmite=Fe_2O_3
CaO=Zero
7
Fe_2O_3=Zero

Figure 2b.

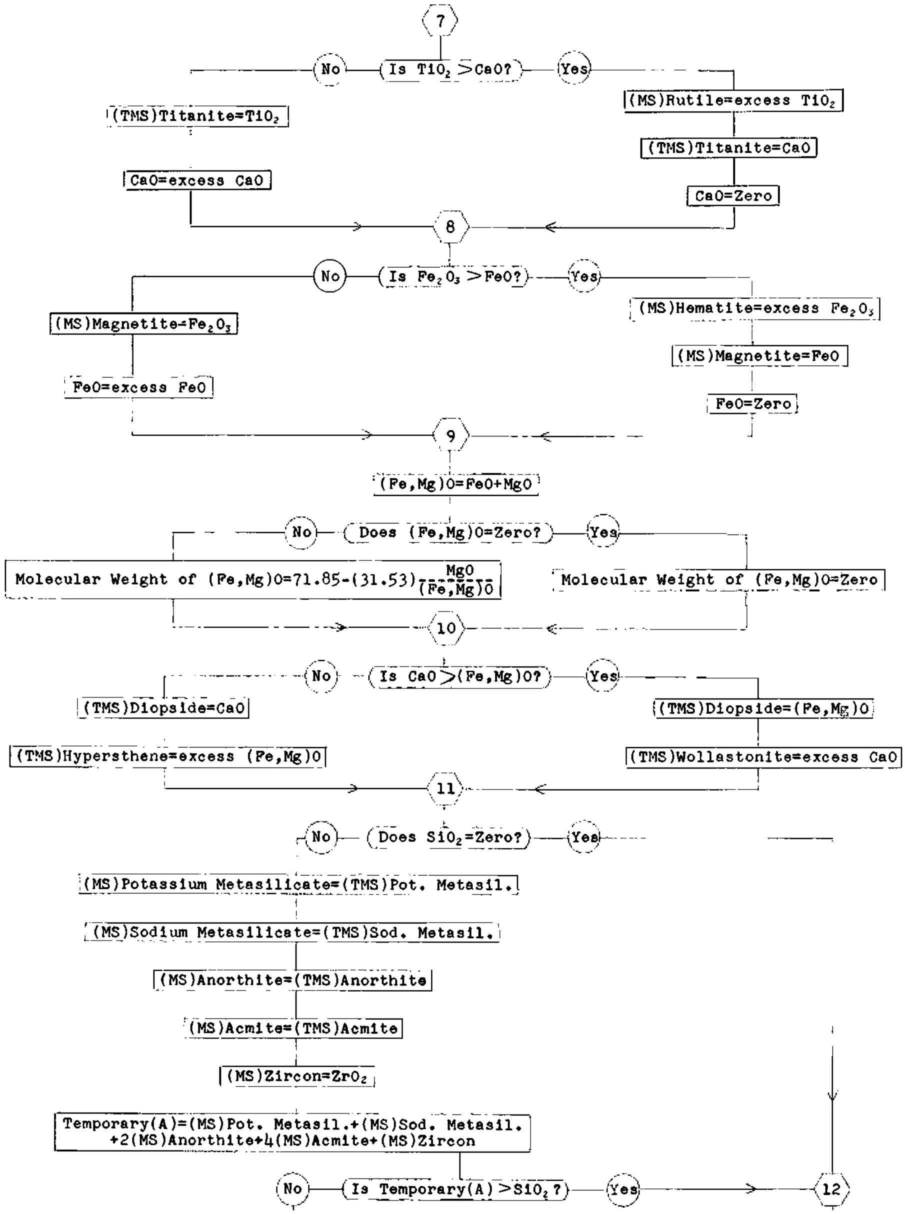

7
Is TiO_2 > CaO?
No
Yes
(MS)Rutile=excess TiO_2
(TMS)Titanite=TiO_2
(TMS)Titanite=CaO
CaO=excess CaO
CaO=Zero
8
Is Fe_2O_3 > FeO?
No
Yes
(MS)Hematite=excess Fe_2O_3
(MS)Magnetite=Fe_2O_3
(MS)Magnetite=FeO
FeO=excess FeO
FeO=Zero
9
(Fe,Mg)O=FeO+MgO
Does (Fe,Mg)O=Zero?
No
Yes
Molecular Weight of (Fe,Mg)O=71.85-(31.53)$\frac{MgO}{(Fe,Mg)O}$
Molecular Weight of (Fe,Mg)O=Zero
10
Is CaO > (Fe,Mg)O?
No
Yes
(TMS)Diopside=CaO
(TMS)Diopside=(Fe,Mg)O
(TMS)Hypersthene=excess (Fe,Mg)O
(TMS)Wollastonite=excess CaO
11
Does SiO_2=Zero?
No
Yes
(MS)Potassium Metasilicate=(TMS)Pot. Metasil.
(MS)Sodium Metasilicate=(TMS)Sod. Metasil.
(MS)Anorthite=(TMS)Anorthite
(MS)Acmite=(TMS)Acmite
(MS)Zircon=ZrO_2
Temporary(A)=(MS)Pot. Metasil.+(MS)Sod. Metasil.
+2(MS)Anorthite+4(MS)Acmite+(MS)Zircon
Is Temporary(A) > SiO_2?
No
Yes
12

Figure 2c.

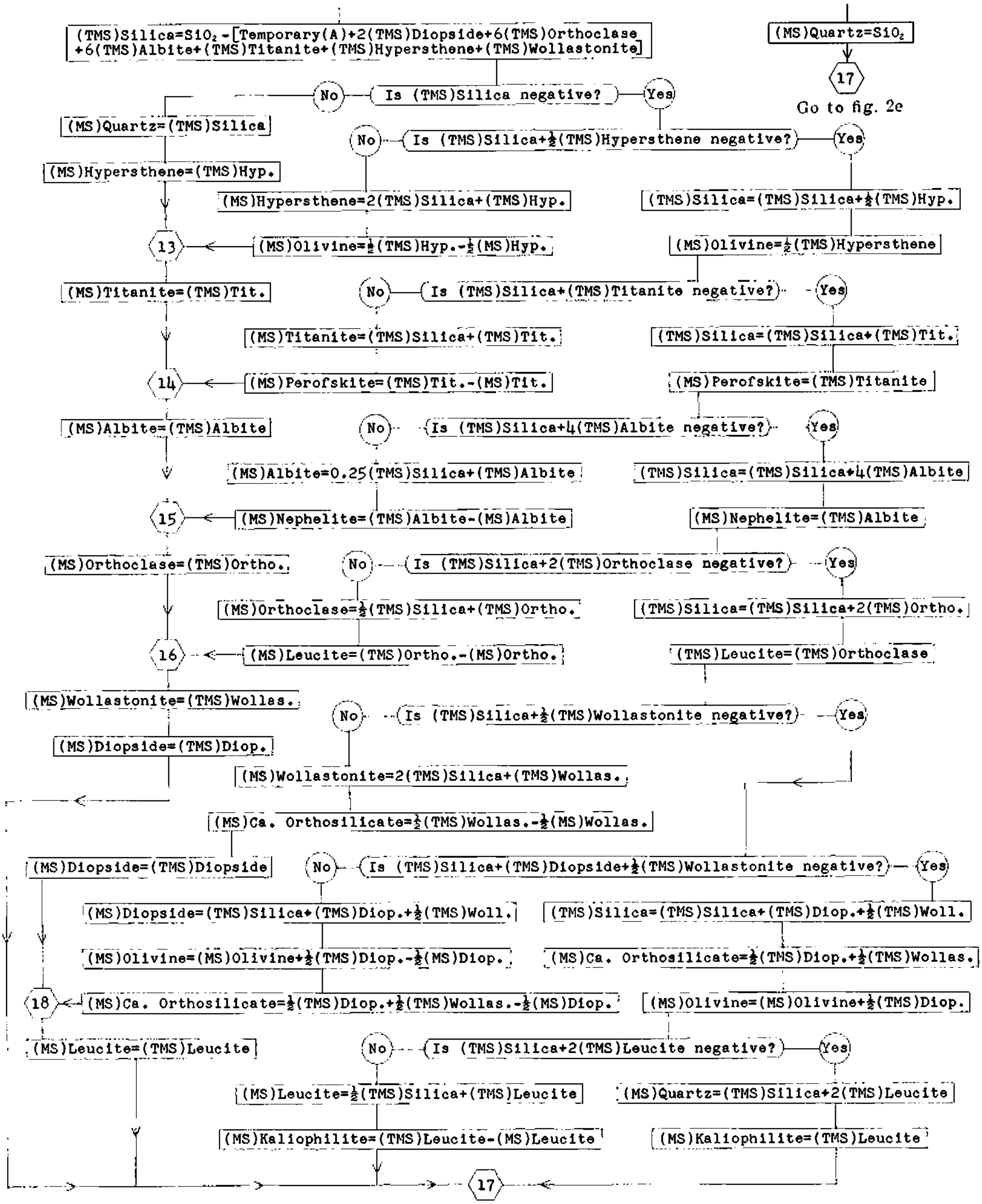

(TMS)Silica=SiO2-[Temporary(A)+2(TMS)Diopside+6(TMS)Orthoclase +6(TMS)Albite+(TMS)Titanite+(TMS)Hypersthene+(TMS)Wollastonite]
(MS)Quartz=SiO2
17
Go to fig. 2e
No
Is (TMS)Silica negative?
Yes
(MS)Quartz=(TMS)Silica
No
Is (TMS)Silica+½(TMS)Hypersthene negative?
Yes
(MS)Hypersthene=(TMS)Hyp.
(MS)Hypersthene=2(TMS)Silica+(TMS)Hyp.
(TMS)Silica=(TMS)Silica+½(TMS)Hyp.
13
(MS)Olivine=½(TMS)Hyp.-½(MS)Hyp.
(MS)Olivine=½(TMS)Hypersthene
(MS)Titanite=(TMS)Tit.
No
Is (TMS)Silica+(TMS)Titanite negative?
Yes
(MS)Titanite=(TMS)Silica+(TMS)Tit.
(TMS)Silica=(TMS)Silica+(TMS)Tit.
14
(MS)Perofskite=(TMS)Tit.-(MS)Tit.
(MS)Perofskite=(TMS)Titanite
(MS)Albite=(TMS)Albite
No
Is (TMS)Silica+4(TMS)Albite negative?
Yes
(MS)Albite=0.25(TMS)Silica+(TMS)Albite
(TMS)Silica=(TMS)Silica+4(TMS)Albite
15
(MS)Nephelite=(TMS)Albite-(MS)Albite
(MS)Nephelite=(TMS)Albite
(MS)Orthoclase=(TMS)Ortho.
No
Is (TMS)Silica+2(TMS)Orthoclase negative?
Yes
(MS)Orthoclase=½(TMS)Silica+(TMS)Ortho.
(TMS)Silica=(TMS)Silica+2(TMS)Ortho.
16
(MS)Leucite=(TMS)Ortho.-(MS)Ortho.
(TMS)Leucite=(TMS)Orthoclase
(MS)Wollastonite=(TMS)Wollas.
No
Is (TMS)Silica+½(TMS)Wollastonite negative?
Yes
(MS)Diopside=(TMS)Diop.
(MS)Wollastonite=2(TMS)Silica+(TMS)Wollas.
(MS)Ca. Orthosilicate=½(TMS)Wollas.-½(MS)Wollas.
(MS)Diopside=(TMS)Diopside
No
Is (TMS)Silica+(TMS)Diopside+½(TMS)Wollastonite negative?
Yes
(MS)Diopside=(TMS)Silica+(TMS)Diop.+½(TMS)Woll.
(TMS)Silica=(TMS)Silica+(TMS)Diop.+½(TMS)Woll.
(MS)Olivine=(MS)Olivine+½(TMS)Diop.-½(MS)Diop.
(MS)Ca. Orthosilicate=½(TMS)Diop.+½(TMS)Wollas.
18
(MS)Ca. Orthosilicate=½(TMS)Diop.+½(TMS)Wollas.-½(MS)Diop.
(MS)Olivine=(MS)Olivine+½(TMS)Diop.
(MS)Leucite=(TMS)Leucite
No
Is (TMS)Silica+2(TMS)Leucite negative?
Yes
(MS)Leucite=½(TMS)Silica+(TMS)Leucite
(MS)Quartz=(TMS)Silica+2(TMS)Leucite
(MS)Kaliophilite=(TMS)Leucite-(MS)Leucite
(MS)Kaliophilite=(TMS)Leucite
17

Figure 2d.

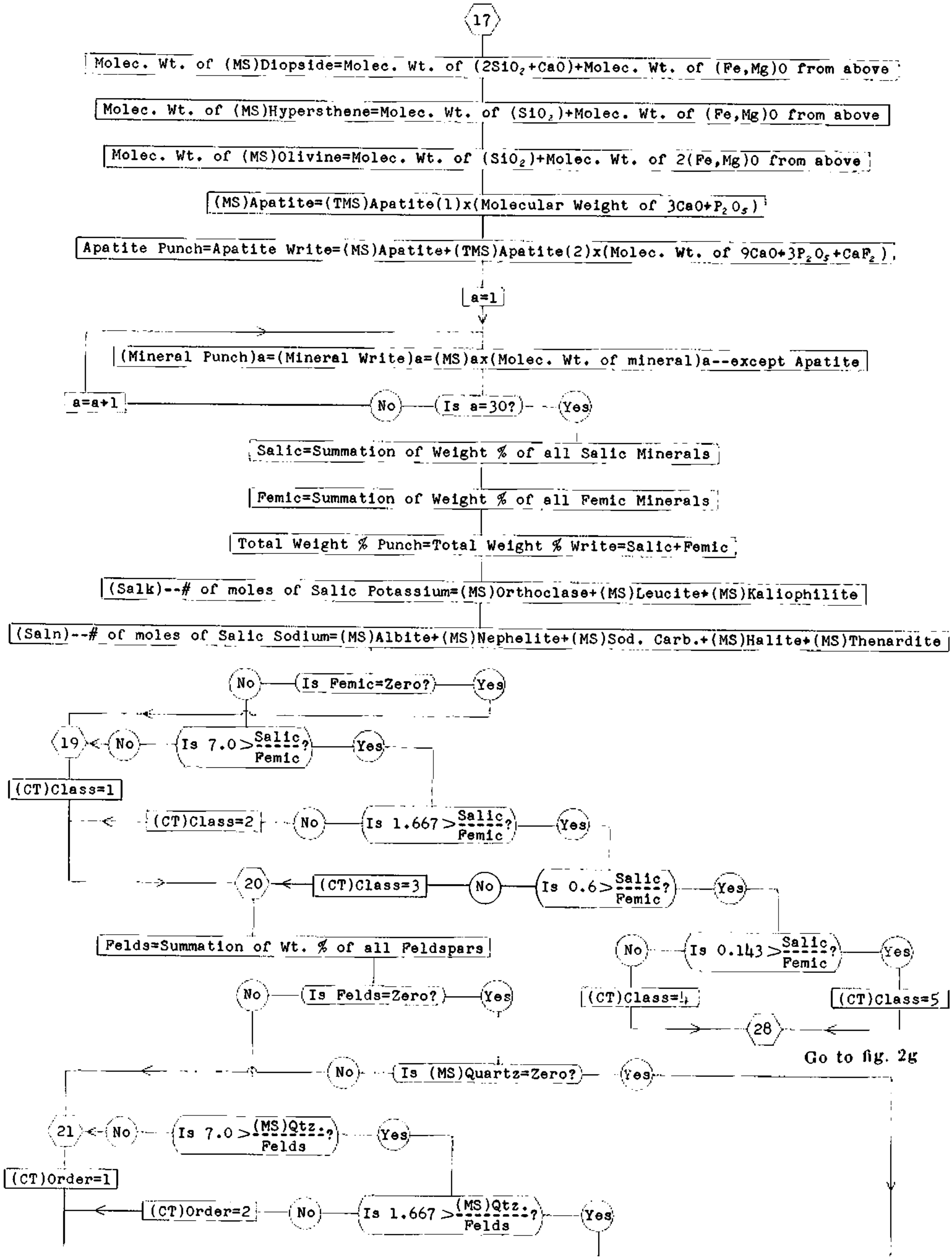
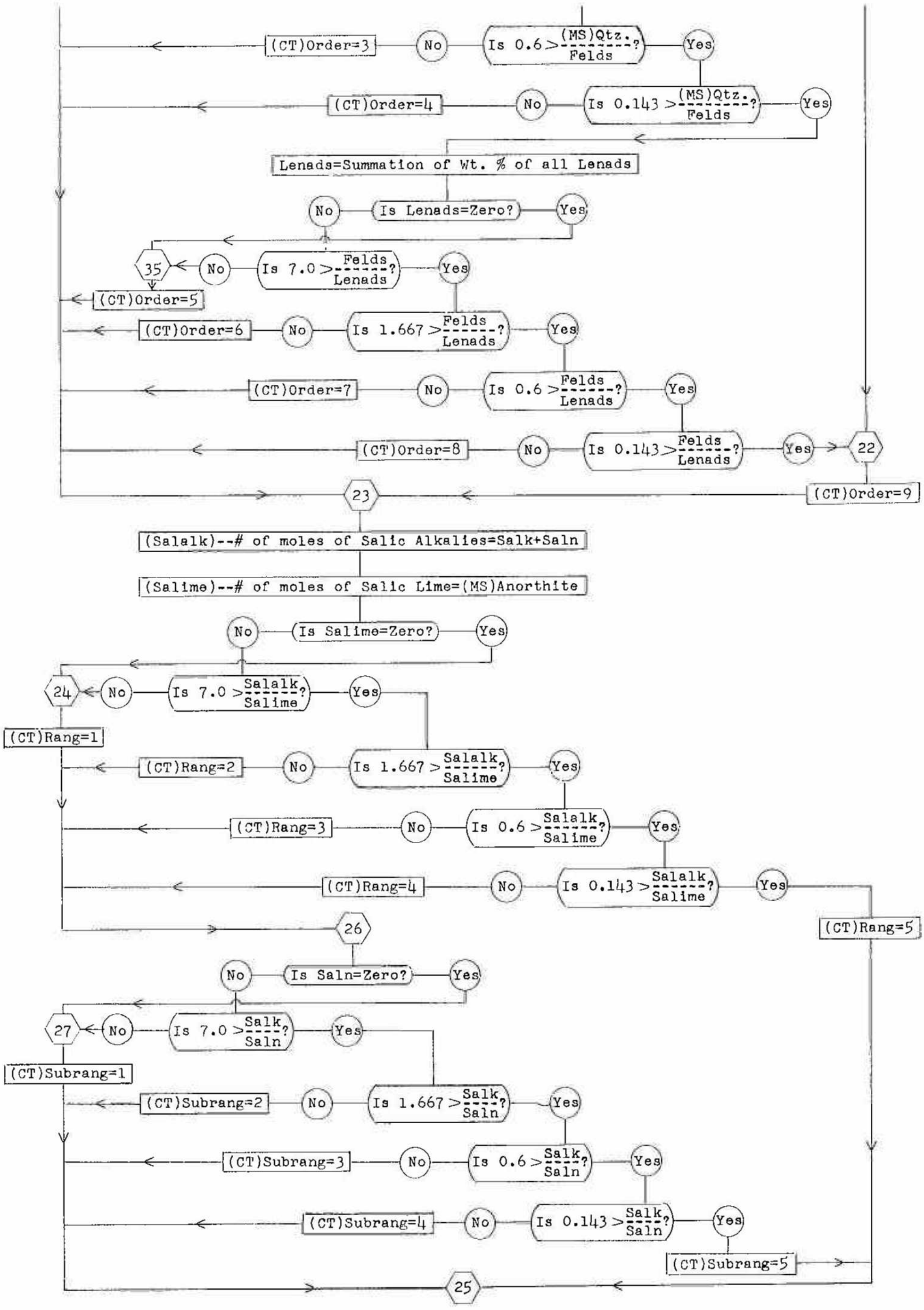

17
Molec. Wt. of (MS)Diopside=Molec. Wt. of ($2SiO_2$+CaO)+Molec. Wt. of (Fe,Mg)O from above
Molec. Wt. of (MS)Hypersthene=Molec. Wt. of (SiO_2)+Molec. Wt. of (Fe,Mg)O from above
Molec. Wt. of (MS)Olivine=Molec. Wt. of (SiO_2)+Molec. Wt. of 2(Fe,Mg)O from above
(MS)Apatite=(TMS)Apatite(1)x(Molecular Weight of $3CaO+P_2O_5$)
Apatite Punch=Apatite Write=(MS)Apatite+(TMS)Apatite(2)x(Molec. Wt. of $9CaO+3P_2O_5+CaF_2$)
a=1
(Mineral Punch)a=(Mineral Write)a=(MS)ax(Molec. Wt. of mineral)a--except Apatite
a=a+1
No
Is a=30?
Yes
Salic=Summation of Weight % of all Salic Minerals
Femic=Summation of Weight % of all Femic Minerals
Total Weight % Punch=Total Weight % Write=Salic+Femic
(Salk)--# of moles of Salic Potassium=(MS)Orthoclase+(MS)Leucite+(MS)Kaliophilite
(Saln)--# of moles of Salic Sodium=(MS)Albite+(MS)Nephelite+(MS)Sod. Carb.+(MS)Halite+(MS)Thenardite
No
Is Femic=Zero?
Yes
19
No
Is 7.0 > Salic/Femic?
Yes
(CT)Class=1
(CT)Class=2
No
Is 1.667 > Salic/Femic?
Yes
20
(CT)Class=3
No
Is 0.6 > Salic/Femic?
Yes
Felds=Summation of Wt. % of all Feldspars
No
Is 0.143 > Salic/Femic?
Yes
No
Is Felds=Zero?
Yes
(CT)Class=4
(CT)Class=5
28
Go to fig. 2g
No
Is (MS)Quartz=Zero?
Yes
21
No
Is 7.0 > (MS)Qtz./Felds?
Yes
(CT)Order=1
(CT)Order=2
No
Is 1.667 > (MS)Qtz./Felds?
Yes

Figure 2e.



Go to fig. 2h

Figure 2f.

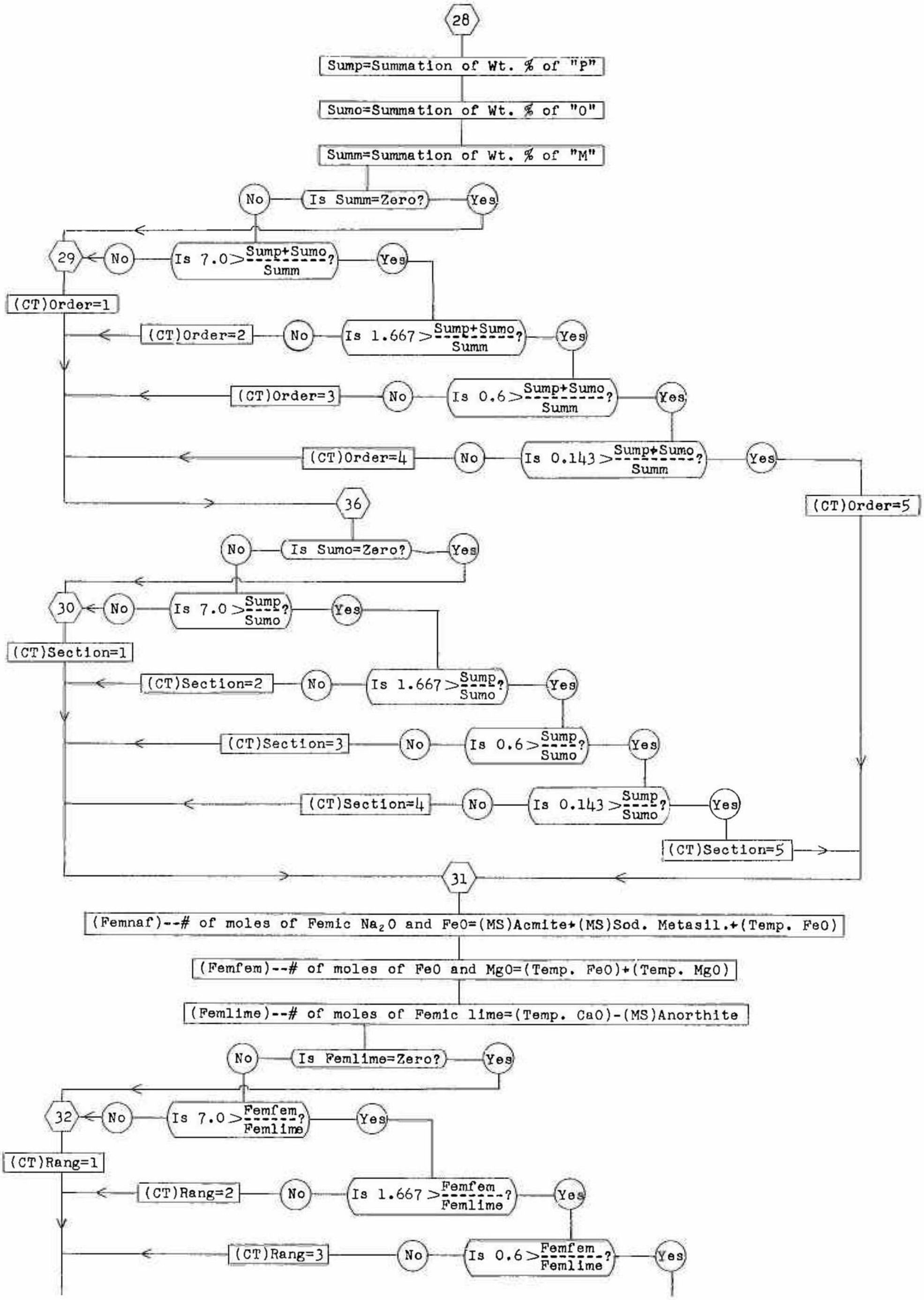
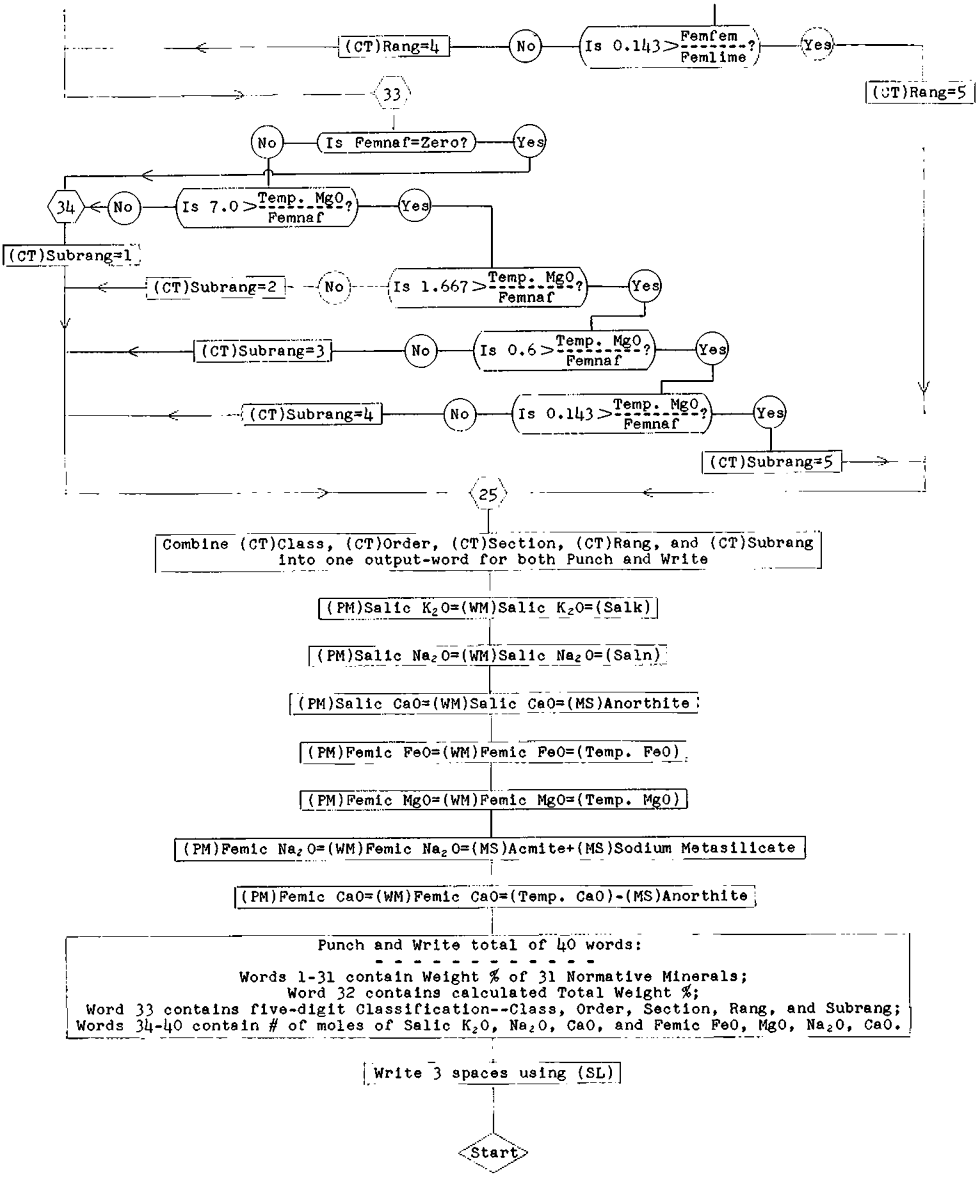

28
Sump=Summation of Wt. % of "P"
Sumo=Summation of Wt. % of "O"
Summ=Summation of Wt. % of "M"
No
Is Summ=Zero?
Yes
29
No
Is 7.0 > Sump+Sumo / Summ ?
Yes
(CT)Order=1
(CT)Order=2
No
Is 1.667 > Sump+Sumo / Summ ?
Yes
(CT)Order=3
No
Is 0.6 > Sump+Sumo / Summ ?
Yes
(CT)Order=4
No
Is 0.143 > Sump+Sumo / Summ ?
Yes
(CT)Order=5
36
No
Is Sumo=Zero?
Yes
30
No
Is 7.0 > Sump / Sumo ?
Yes
(CT)Section=1
(CT)Section=2
No
Is 1.667 > Sump / Sumo ?
Yes
(CT)Section=3
No
Is 0.6 > Sump / Sumo ?
Yes
(CT)Section=4
No
Is 0.143 > Sump / Sumo ?
Yes
(CT)Section=5
31
(Femnaf)--# of moles of Femic Na2O and FeO=(MS)Acmite+(MS)Sod. Metasil.+(Temp. FeO)
(Femfem)--# of moles of FeO and MgO=(Temp. FeO)+(Temp. MgO)
(Femlime)--# of moles of Femic lime=(Temp. CaO)-(MS)Anorthite
No
Is Femlime=Zero?
Yes
32
No
Is 7.0 > Femfem / Femlime ?
Yes
(CT)Rang=1
(CT)Rang=2
No
Is 1.667 > Femfem / Femlime ?
Yes
(CT)Rang=3
No
Is 0.6 > Femfem / Femlime ?
Yes

Figure 2g.



(CT)Rang=4
No
Is 0.143 > Femfem / Femlime ?
Yes
(CT)Rang=5
33
No
Is Femnaf=Zero?
Yes
34
No
Is 7.0 > Temp. MgO / Femnaf ?
Yes
(CT)Subrang=1
(CT)Subrang=2
No
Is 1.667 > Temp. MgO / Femnaf ?
Yes
(CT)Subrang=3
No
Is 0.6 > Temp. MgO / Femnaf ?
Yes
(CT)Subrang=4
No
Is 0.143 > Temp. MgO / Femnaf ?
Yes
(CT)Subrang=5
25
Combine (CT)Class, (CT)Order, (CT)Section, (CT)Rang, and (CT)Subrang into one output-word for both Punch and Write
(PM)Salic K₂O=(WM)Salic K₂O=(Salk)
(PM)Salic Na₂O=(WM)Salic Na₂O=(Saln)
(PM)Salic CaO=(WM)Salic CaO=(MS)Anorthite
(PM)Femic FeO=(WM)Femic FeO=(Temp. FeO)
(PM)Femic MgO=(WM)Femic MgO=(Temp. MgO)
(PM)Femic Na₂O=(WM)Femic Na₂O=(MS)Acmite+(MS)Sodium Metasilicate
(PM)Femic CaO=(WM)Femic CaO=(Temp. CaO)-(MS)Anorthite
Punch and Write total of 40 words:
Words 1-31 contain Weight % of 31 Normative Minerals;
Word 32 contains calculated Total Weight %;
Word 33 contains five-digit Classification--Class, Order, Section, Rang, and Subrang;
Words 34-40 contain # of moles of Salic K₂O, Na₂O, CaO, and Femic FeO, MgO, Na₂O, CaO.
Write 3 spaces using (SL)
Start

Figure 2h.

a

QUARTZ	ORTHO.	ALBITE	ANORTH.	LEUCITE	NEPHEL.	KALIOPH.	CORUNDUM
2793685152	2411184752	2980360852	1243719652				1132234451
ZIRCON	SOD.CARB	HALITE	THENAR.	ACMITE	SOD.META	POT.META	DIOPSIDE
1190131550		3297236349					
WOLLAS.	HYPER.	OLIVINE	CA.ORTH	MAGNET.	CHROMITE	HEMATITE	ILMENITE
	3153868051			8989417750			4178347950
RUTILE	TITANITE	PEROF.	PYRITE	FLUORITE	CALCITE	APATITE	TOT.WT.
						2185206150	1002628953
CLASSIF	SAL K2O	SAL NAO	SAL CAO	FEM FEO	FEM MGO	FEM NAO	FEM CAO
14023	4331210249	5738799349	4470273849	2034719049	1339285749		2113420048

b

QUARTZ	ORTHO.	ALBITE	ANORTH.	LEUCITE	NEPHEL.	KALIOPH.	CORUNDUM
			9964143351	1251172052	2108401452		
ZIRCON	SOD.CARB	HALITE	THENAR.	ACMITE	SOD.META	POT.META	DIOPSIDE
							3613295152
WOLLAS.	HYPER.	OLIVINE	CA.ORTH	MAGNET.	CHROMITE	HEMATITE	ILMENITE
		7946290151	1057127551	5031174051			3798498151
RUTILE	TITANITE	PEROF.	PYRITE	FLUORITE	CALCITE	APATITE	TOT.WT.
						8740824250	9840000052
CLASSIF	SAL K2O	SAL NAO	SAL CAO	FEM FEO	FEM MGO	FEM NAO	FEM CAO
38024	2866242049	7420551749	3581390049	1003479550	2120535750		1828023650

Figure 3. Computer-processed CIPW classification of granite (a) and microgabbro (b), derived from input data given in table II. The first four lines of figures for each rock give the weight percentages of the 31 normative minerals and the total weight percentage of the norm. The fifth and last line shows the numerical classification as to class, order, section (where applicable), rang, and subrang, and also the number of moles of the salic and femic oxides used in classifying the rock.

In reading "floating-point" numbers, the first eight digits are significant figures and the last two digits determine the location of the decimal point. The numerical difference between the last two digits and 50 is the number of spaces the decimal point is moved from the left margin; the decimal moves to the right or left depending on whether the number is respectively more or less than 50. For example, several weight percentages in the granite are quartz 27.94, corundum 1.13, and zircon 0.12. Also the number of moles of salic K_2O in the granite is 0.0433. See table III for the comparison of these computer-calculated norms with those calculated by hand.

The greatest problem appears to be the treatment of calcium oxide and carbon dioxide with relation to the presence or absence of calcite. It is here suggested that the response to the question "Any calcite?" (fig. 2b) be "Yes" when modal calcite exists (whether it is primary or secondary) or when the modal carbonate is not identified. If primary calcite is known to be present in the rock, the question "Is it primary?" should be answered "Yes"; otherwise the question should be answered "No." The response to the question "Any calcite?" should be "No" if it is known that some other carbonate (e. g., siderite) is the source of the CO_2. This treatment of the calcite problem will enable a more accurate allotment of CaO to the remainder of the normative minerals, and allow only primary calcite to be considered in the norm.

The weight percentages of 21 common oxides and elements, together with "Yes" or "No" answers to four questions regarding the mode, constitute the input data necessary to the CIPW classification (table I). The chemical analyses of two igneous rocks are presented in table II, and their computer-calculated norms and classifications are

TABLE III.—COMPARISON OF NORMS AS DETERMINED BY COMPUTER AND BY HAND CALCULATIONS

	Granite—El Capitan			Microgabbro—Coral Island		
	COMPUTER[1]	HAND[2]	DIFF.	COMPUTER[1]	HAND[3]	DIFF.
Quartz	27.94	28.20	−0.26			
Orthoclase	24.11	23.91	+0.20			
Albite	29.80	29.87	−0.07			
Anorthite	12.47	12.23	+0.24	9.96	10.01	−0.05
Leucite				12.51	12.64	−0.13
Nephelite				21.08	21.02	+0.06
Corundum	1.13	1.22	−0.09			
Zircon	0.12	[2]	+0.12			
Halite	0.03	[2]	+0.03			
Diopside				36.13	36.05	+0.08
Hypersthene	3.15	3.12	+0.03			
Olivine				7.95	7.99	−0.04
Ca-Orthosilicate				1.06	0.86	+0.20
Magnetite	0.90	0.93	−0.03	5.03	5.10	−0.07
Ilmenite	0.42	0.46	−0.04	3.80	3.80	0.00
Apatite	0.22	0.34	−0.12	0.87	1.01	−0.14
Total	100.26	100.28	−0.02	98.40	98.48	−0.08

[1]Figure 3.
[2]Washington (1917, p. 185). ZrO_2 and Cl disregarded in calculation.
[3]Washington (1917, p. 699).

shown in figure 3. These are compared with hand-calculated norms of the same two rocks in table III.

The information obtained by use of the program includes (fig. 3): the weight percentages of the 31 normative minerals; the total weight percentage of the norm; the numerical classification of the rock as to class, order, section (where applicable), rang, and subrang; and the number of moles of salic and femic oxides used in classifying the rock. This last group of data is useful in determining whether the classification is a borderline case.

References Cited

Cross, Whitman, Iddings, J. P., Pirsson, L. V., and Washington, H. S., 1902, A quantitative chemico-mineralogical classification and nomenclature of igneous rocks: Jour. Geology, vol. 10, p. 555-690.

———— 1903, Quantitative classification of igneous rocks: University of Chicago Press, 286 p.

Johannsen, Albert, 1931, A descriptive petrography of the igneous rocks; Volume I, Introduction, textures, classifications, and glossary: University of Chicago Press, 319 p.

Washington, H. S., 1917, Chemical analyses of igneous rocks: U. S. Geol. Survey, Prof. Paper 99, 1201 p.

Mespilocystites, AN ORDOVICIAN CORONATE CRINOID FROM CZECHOSLOVAKIA

ROBERT O. FAY

Mespilocystites bohemicus Barrande, 1887, the type species for the genus, occurs in Upper Llandeilo Letná beds from Chrustenice near Beroun, and Blyskava near Loděnice, Czechoslovakia. The fossils occur as limonitic molds and casts in gray to tan sandy dolomite. Barrande reported *M. bohemicus* from Stage Dd_4 at Zahořan and Stage Dd_2 at Trubsko, Czechoslovakia. According to Bubnoff (1930, p. 438-440) and Dorn (1960, table 3), Dd_4 is now part of Stage d_ε and is the Letná beds, whereas Dd_2 is now d_δ below the Letná beds and Middle Llandeilo in position. I was unable to study the type specimens, and the following description is based upon observations of specimens recently collected by Dr. V. Havlíček and Dr. Rudolf Prokop of the Central Geological Survey, Prague, Czechoslovakia. Dr. Prokop kindly loaned me five specimens from Chrustenice, herein described, and donated eleven specimens from Blyskava to the paleontology collection of The University of Oklahoma.

Class CRINOIDEA
Order CORONATA Jaekel, 1918
Genus *Mespilocystites* Barrande, 1887

Type species—Mespilocystites bohemicus Barrande, 1887, p. 163, pl. 38, figs. 1-10.

Theca small, widely flaring, composed of three basals and five radials, with five interradials confined to summit in broad deep ventral concavity; each of the five short, bluntly rounded ambulacra appears to be covered by two cylindrical cover plates, with a sharply defined triangular area at the aboral ends extending along the ventral face of each radial plate. The oral area is obscured, and the anal area is apparently adoral to the anal coronal process at the aboral end of the anal interradial plate. Middle Ordovician, Llandeilo, Stage $\mathbf{d}_\varepsilon$, Letná beds, and Stage $\mathbf{d}_\delta$, Czechoslovakia.

Mespilocystites bohemicus Barrande, 1887
Plates I, II, text-figures 1-3

Thecae small, limonitic, occurring as molds and casts in sandy dolomite, with plates delineated as flat areas and sutures appearing as ridges or faint lines. Thecae averaging 4 mm high by 4-5 mm wide, broadly cup-shaped, with coronal processes 1 mm high, and pelvic angle on sides approximately 75 degrees. In basal view, the coronal processes project outward in broadly rounded nodes, and the sides along the middle faces of the radials bend outward in a low arch, giving the appearance of a bracket to each side of the theca. In top view, the radial arches are not prominent and the coronal processes impart a strongly pentalobate appearance.

Plate I

Mespilocystites bohemicus **Barrande, 1887. Middle Ordovician, Upper Llandeilo, Letná beds, Chrustenice, Czechoslovakia. Aboral view of summit from the interior of plesiotype 2380A, x20.0.**

An—anal opening
C—coronal process
Cv—cover plate
IR—interradial plate
O—oral area
R—radial plate

Basals three, large, with broadly pentagonal basal circlet 1.5 mm high by 2.5 mm wide, and aboral tip sharply pointed to receive small stem 0.25 mm wide. The stem is not preserved but the flat area of attachment for the stem is present.

Radials five, each elongate subpentagonal, about 2.5 mm long by 1.5 mm wide, with limbs projecting into high coronal processes about 1 mm above summit plane, and adoral end of each radial slightly notched to receive the broadly rounded aboral end of each ambulacrum. The radial sinus is about 0.25 mm long by 0.25 mm wide and is confined to the ventral surface. A large triangular area is present on each radial at the aboral end of each ambulacrum, 1 mm long by 0.25 mm

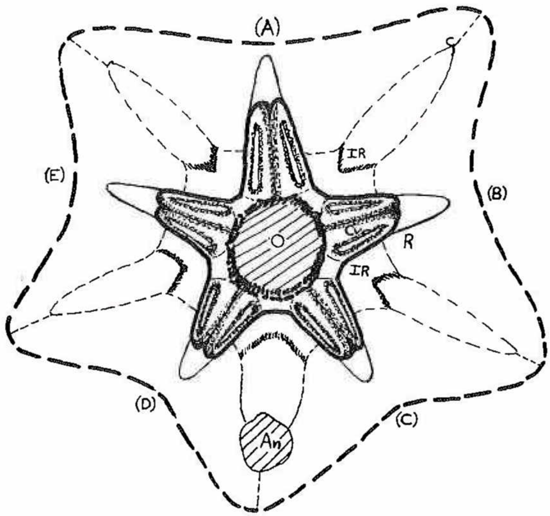


Figure 1. Mespilocystites bohemicus. **Camera lucida drawing of interpretations of morphological features of plesiotype 2380A, in oral view. The drawing was made by reversing from left to right the original drawing of the specimen, x15.0.**

(A)—anterior ambulacrum	**Cv—cover plate**
An—anal opening	**(D)—left posterior ambulacrum**
(B)—right anterior ambulacrum	**(E)—left anterior ambulacrum**
(C)—right posterior ambulacrum	**IR—interradial plate**
c—coronal process	**O—oral opening**

R—radial plate

wide, mainly confined to the ventral surface but extending aborally to the dorsal side. This area appears to have been formed as a growth pattern around the aboral end of an ambulacrum. In addition, it is possible that a primaxil plate was present at the aboral end of each ambulacrum and the impression of this plate forms part of the base of the triangular area.

Interradials five, elongate subheptagonal, each 1.5 mm long by 0.75 mm wide, confined to ventral cup, with an aboral elongate portion extending into a coronal process. The sutures are obscure, but fine growth lines delineate the approximate positions of the sutures. The adoral portion of each interradial plate is broadly quadrangular, between adjacent ambulacra, with a small flattened adoral end that may have abutted against an oral plate. The coronal process forms a sharp V-shaped ridge, about 0.1 mm aborally from the adoral tip of

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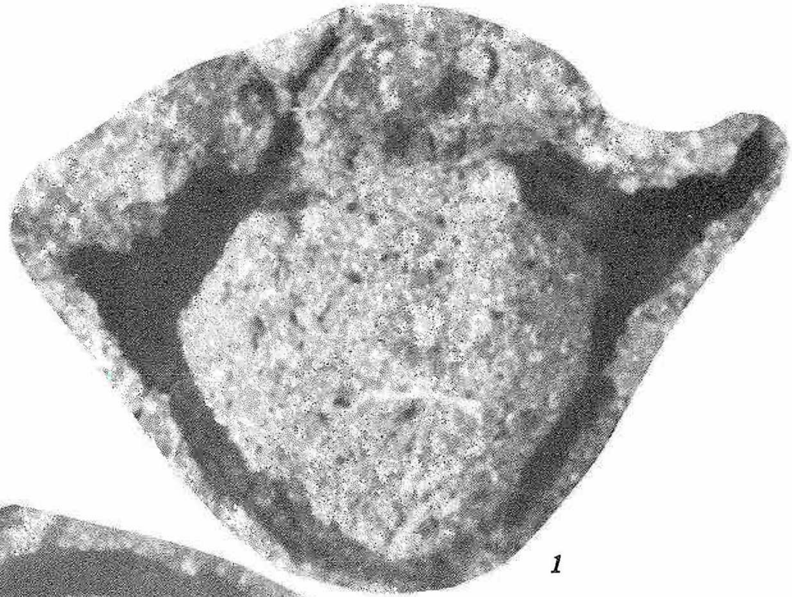
Explanation of Plate II

Mespilocystites bohemicus **Barrande, 1887. Middle Ordovician, Upper Llandeilo, Letná beds, Chrustenice, Czechoslovakia.**

Figure 1. **Side view of internal and external molds of plesiotype 2380C, x21.5.**

Figure 2. **Aboral view of internal and external molds of plesiotype 2380B, x21.0.**

Plate II



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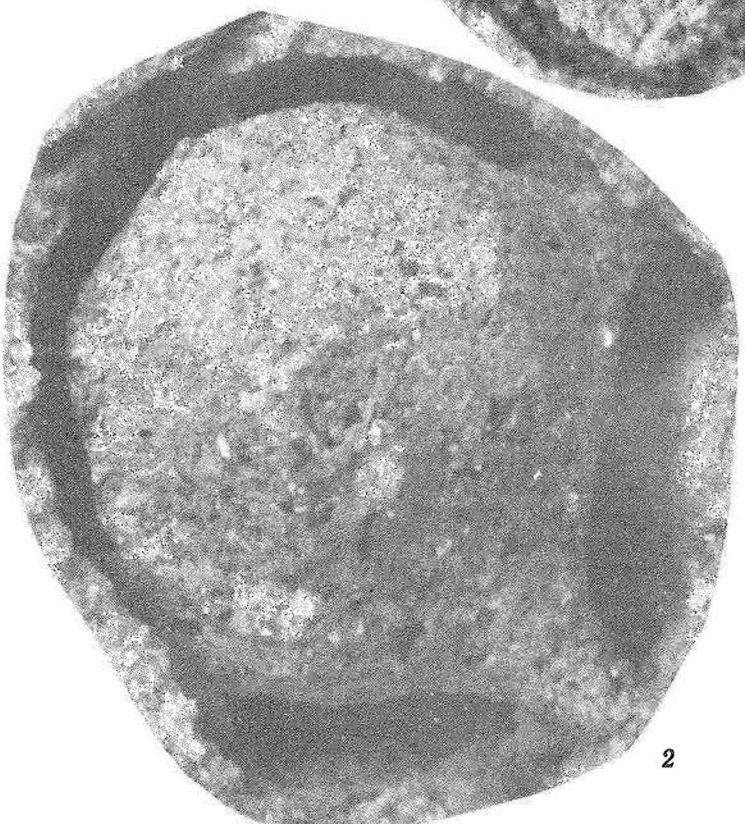

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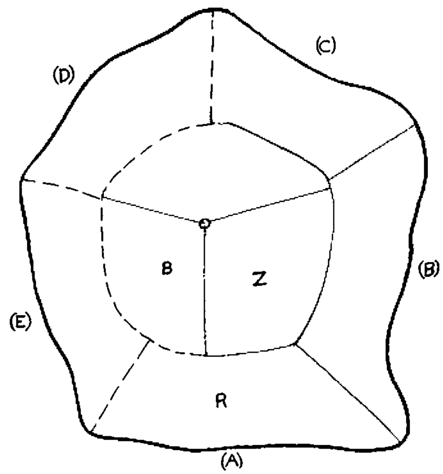


Figure 2. Mespilocystites bohemicus. **Camera lucida drawing of interpretations of morphological features of plesiotype 2380B in aboral view, x15.0.**

(A)—anterior ambulacrum
(B)—right anterior ambulacrum
B—basal plate
(C)—right posterior ambulacrum
(D)—left posterior ambulacrum
(E)—left anterior ambulacrum
R—radial plate
Z—azygous basal plate

each interradial, and is sharply elongate along the aboral part of the interradial. It is presumed that the radial plates are in lateral contact from the dorsal to the ventral surface, perhaps extending beneath the aboral portions of the interradials. On the anal side, the anal interradial appears to be broader than the other four, and the coronal process appears to be lower, with the anal opening at the juncture of the aboral tip of the anal interradial with the (C) and (D) radials.

The oral region is filled with matrix and the only recognizable features of the peristome are small flat areas, interradial in position, abutting against the adoral tips of the interradials. If *Mespilocystites* may be compared with *Stephanocrinus,* these flat areas may be interpreted as portions of the oral plates. Thus there would be five oral plates, interradial in position, covering the mouth.

Ambulacra five, short, bluntly rounded aborally, each approximately 0.75 mm long by 0.5 mm wide, with a central food groove and two small parallel ridges on either side of the main food groove. The main food groove is broader aborally and appears to bifurcate aborally to form two food grooves. The ridges appear to be raised portions of elongate cover plates; thus it is possible that two long cover plates covered each ambulacrum, abutting against the oral plates. Arms unknown, but perhaps similar to those of *Stephanocrinus angulatus.*

The ornamentation consists of coarse ridges at right angles to the lateral radial sutures on the coronal processes, and subparallel to the basiradial sutures on the basal plates. Barrande (1887, pl. 38, figs. 9-10) illustrated conflicting types of patterns on the aboral parts of the radials, and therefore this portion is not shown in text-figure 3. The basal ornamentation was copied after Barrande and the coronal ridges

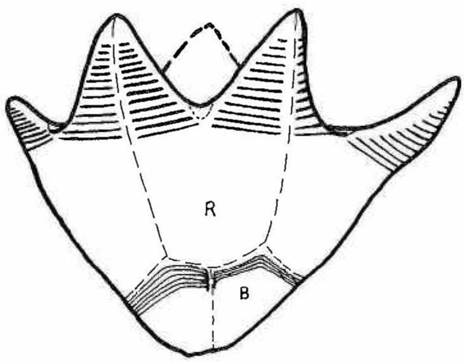


Figure 3. Mespilocystites bohemicus. **Camera lucida drawing of interpretations of morphological features of plesiotype 2380C, in side view. The ornamentation of the coronal process is copied from specimen 2380A, and the ornamentation of the basals is copied from Barrande (1887, pl. 38, fig. 10), x15.0.**

B—basal plate **R—radial plate**

were copied from specimen 2380A. The coronal portion is similar to a pore-rhomb pattern, but the ridges and grooves are surficial, are confined to the external molds, and do not extend to the internal molds. Barrande stressed the ornamentation above other features and therefore classed *Mespilocystites* with the pore-rhomb cystoids.

Remarks.—*Mespilocystites* has features similar to those of *Stephanocrinus* and allied forms of coronate crinoids. *M. bohemicus* is the only described species, and the genus differs from the others by having a broadly flaring dorsal cup, large triangular areas at the aboral ends of the ambulacra, a sharply pointed dorsal cup, and a small theca.

Types and occurrence.—Plesiotypes, 2380A-E, Central Geological Survey, Prague, Czechoslovakia; Middle Ordovician, Upper Llandeilo, Letná beds, Chrustenice, Czechoslovakia, collected by Dr. V. Havlíček in 1959. Plesiotypes, OU 4723, eleven specimens, The University of Oklahoma paleontology collection, Norman, Oklahoma; Middle Ordovician, Upper Llandeilo, Letná beds, from Blyskava north of Loděnice, Czechoslovakia, collected by Dr. Rudolf Prokop in 1961. The original syntypes are in the Czechoslovakia National Museum, Barrandeum Room, Prague; from the Middle Ordovician, Upper Llandeilo Dd beds at Zahořan, and Middle Llandeilo Dd$_2$ beds at Trubsko, Czechoslovakia.

References Cited

Barrande, Joachim, 1887, Système Silurien de centre de la Bohême. Part I: Recherches Paléontologiques, continuation éditée par le Musée Bohême. Vol. VIII, Classe des Echinodermes, Ordre des Cystidées: 8 vo., p. 1-213, pls. 1-39, tables 1-10 (Prague).

Bubnoff, Serge von, 1930, Geologie von Europa; Zweiter Band, Erster Teil, Kaledoniden und Varisciden: Geologie der Erde, Krenkel, ed., p. 1-690, pls. 1-4, text-figs. 1-201 (Berlin).

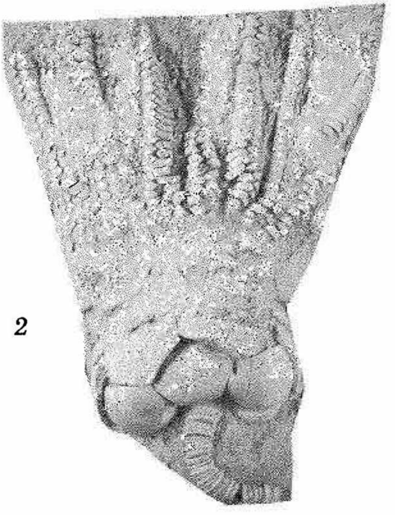
Dorn, Paul, 1960, Geologie von Mitteleuropa: xvi+ p. 1-488, pls. 1-19, figs. 1-126, charts 1-11 (Stuttgart).

Jaekel, O. M. J., 1918, Phylogenie und system der Pelmatozoen: Paläontologisches Zeitschrift, vol. 3, heft 1, p. 1-128, figs. 1-114, reprinted in 1921 (Berlin).

Additional Illustrations of Some Oklahoma Crinoids

The genus *Schedexocrinus* was erected by Strimple (1961, p. 27-29) for the species *S. gibberellus* from the top of the Holdenville Formation of Okmulgee County. Strimple figured several specimens and identified many more. The specimen here figured is a paratype, OU 4198.

The new genus *Metaperimestocrinus* was established by Strimple (1961, p. 36-37) for *M. spiniferus* from the same locality and horizon.



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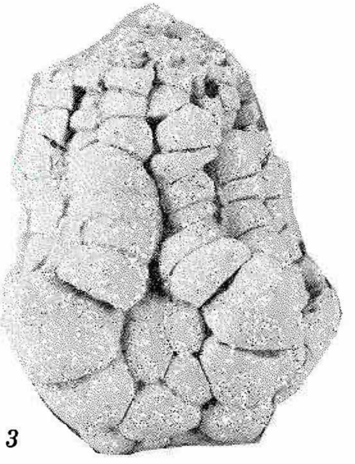

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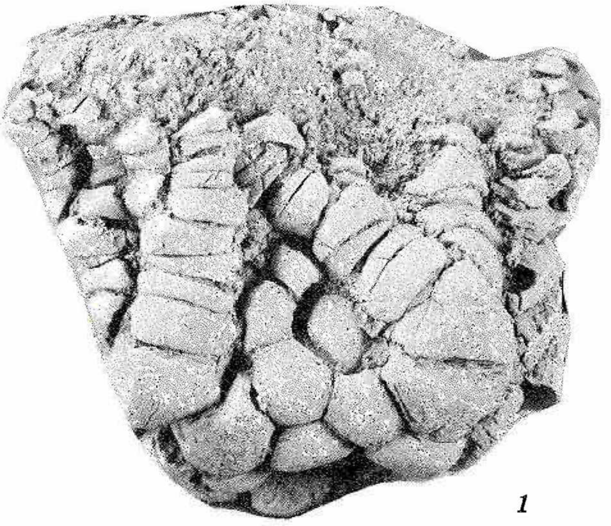

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Figure 4. Crown of paratype of Metacromyocrinus holdenvillensis **Strimple, xl.**

The specimen is a paratype, OU 4013, figured by Strimple on plate 4, figures 5-7.

Parethelocrinus ellipticus is a species described by Strimple (1961, p. 83-85) from the same locality and illustrated by plate 18, figure 1.

The excellently preserved crowns from this Oklahoma locality are deserving of illustration in the best possible manner. William Bellis photographed them with the B and L camera and Polaroid attachment of the School of Geology.

The new genus *Metacromyocrinus* and its type species, *M. holdenvillensis,* were described by Strimple on pages 68-73. The holotype of the type species was figured on plate 6, figures 1-3. A paratype is figured here as figure 4.

Reference Cited

Strimple, H. L., 1961, Late Desmoinesian crinoid faunule from Oklahoma: Okla. Geol. Survey, Bull. 93, 189 p.

—C. C. B.

Figure 1. Posterior view of crown of a paratype of Schedexocrinus gibberellus **Strimple, x2.**

Figure 2. A crown of Parethelocrinus ellipticus **Strimple, a paratype, x0.5.**

Figure 3. Posterior view of a paratype crown of Metaperimestocrinus spiniferus **Strimple, x3.**

On *Schizoblastus*? *devonianus* from the Onondaga Limestone, New York

Robert O. Fay

The genus *Schizoblastus,* as now understood, is restricted to Middle Mississippian rocks of North America and therefore, a recorded occurrence of this genus outside the known range is questionable. The holotype of the species *Schizoblastus*? *devonianus* Reimann, 1945, from the Middle Devonian Onondaga Limestone, LeRoy, New York, is in the Buffalo Society of Natural Sciences Museum, number E 16,101. It is a fragmentary specimen, probably representing some new genus, but it has some characters that are indeterminable because of the poor preservation, and therefore a new name is not here proposed. The species does not belong to *Schizoblastus.*

The specimen is calcitic, partly in limestone, ellipsoidal, 11 mm or more long by 6 mm wide, with periphery about midheight. The base is crushed and partly destroyed but probably the basalia was small. Each deltoid is lancet shaped, 8 mm long by 3.5 mm wide, with broadly rounded V-shaped radiodeltoid suture extending below periphery. Two

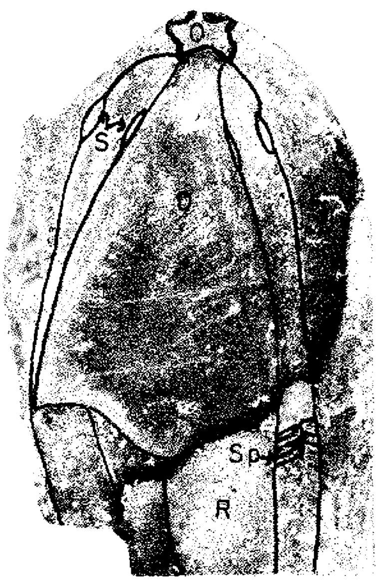

Figure 1. Schizoblastus? devonianus **Reimann, 1945. Side view of holotype showing left anterior "A-E" deltoid plate, with "A" ambulacrum on left and "E" ambulacrum on right. E 16,101, Buffalo Society of Natural Sciences, Buffalo, New York. From Middle Devonian, Onondaga Limestone, LeRoy, New York, x6.4**

D—deltoid plate **R—radial plate**
O—oral plate or opening **S—spiracles**
Sp—side plates

spiracles are notched in the adoral ends of each deltoid, along the ambulacral margins and well away from the oral opening. The anal spiracles were not observed, and thus it is impossible to determine the nature of the anal side. The radials overlap the deltoids.

Each radial appears to be broadly pentagonal and almost as long as the deltoids. Each is approximately 5 mm long by 4 mm wide, with a moderately long narrow radial sinus, approximately 4 mm long by 1 mm wide. The lancet is covered by the side plates, with 40 side plates in 10 mm length of an ambulacrum, one pore between side plates along the radial and deltoid margins, and three cover-plate sockets per side plate along the main food groove. The side plates appear to be disposed normally, with the small subtriangular secondary side plate resting upon the bevelled adoral-abmedial corner of each primary side plate. The surfaces of the deltoid and radial plates are ornamented with fine growth lines subparallel to the plate margins. Although one ambulacrum was partially sectioned, it was impossible to determine the number of hydrospires. A large pentagonal oral plate appears to cover the oral opening, but it is partially destroyed. The specimen is illustrated in figure 1.

The genus *Schizoblastus* has long deltoids that overlap the radials and a lancet exposed along the main food groove, two characteristics that are absent in the Devonian specimen. Possibly the above new genus gave rise to *Schizoblastus* by means of downward migration of the deltoids over the radials and by outward migration of the lancet plate to the surface. This possibility would be more likely if it can be shown in the Devonian form that the spiracles on the anal side are separate from the anal opening, that the anal opening is between an epideltoid and a hypodeltoid plate, and that two or more hydrospire folds occur on each side of an ambulacrum.

Reference Cited

Reimann, I. G., 1945, New Devonian blastoids: Buffalo Society Natural Sciences, Bull., vol. 19, no. 2, p. 40, pl. 8, fig. 6.

Conodonts from Asia

The first conodonts described were from the Ordovician of Esthonia and from the Mississippian of European Russia. Knowledge of these minute tooth-like and jaw-like fossils was slow in accumulating. They were first found in the United States in 1873, in Germany in 1877, in Scotland in 1900, in Africa (Egypt) in 1940, and in Australia in 1943. They are as yet unreported from Central America, South America, Antarctica, Arctic America, and Asia Minor.

My father, E. B. Branson, searched for conodonts in Europe and was able to find sparse and poorly preserved specimens in the Devonian and Lower Mississippian of the Harz Mountains, was given specimens from the Hauptmuschelkalk (Branson and Mehl, 1941), and his material contained some specimens from the Mississippian of Ireland and from Devonian of southern Russia.

The first report of Asian conodonts is an article by Ching (1960) in which discovery of Upper Devonian and Pennsylvanian forms from Szechuan, and Middle Devonian and Mississippian forms from Kweichow is reported, and a fauna from the Lower Permian of the Nanking Hills is described. Genera identified are *Neoprioniodus, Ozarkodina, Synprioniodina, Lonchodina,* and *Gondolella.* The fauna is remarkably like that of the Muschelkalk of Oberhesse, in which *Ozarkodina, Lonchodina,* and *Gondolella* occur (Tatge, 1956). The genus *Ozarkodina,* recorded in both faunas, is probably not that Silurian genus, but a new one.

References Cited

Branson, E. B., and **Mehl, M. G.,** 1941, A record of typical American conodont genera in various parts of Europe: Denison Univ., Jour. Sci. Laboratories, vol. 35, p. 189-194.

Ching, Yü-Kan, 1960, Conodonts from the Kufeng suite (formation) of Lungtan, Nanking: Acta Palaeontologica Sinica, vol. 8, no. 3, p. 230-241 (in Chinese), 242-248 (in English), plates 1-2.

Tatge, Ursula, 1956, Conodonten aus dem germanischen Muschelkalk: Palaeontologische Zeitschrift, vol. 30, p. 108-147.

—C. C. B.

?? Have You Any Basement Rock Samples from Northeastern Oklahoma ??

The Oklahoma Geological Survey has collected basement-rock samples from about 90 wells in northeastern Oklahoma in order to describe petrographically the igneous rocks in the subsurface of that area. Of the samples studied less than 30 percent are granite, the remainder being igneous flow rocks and other types of volcanic rock.

We are now looking for samples from the following wells:

Frankfort No. 1 Allsup, sec. 1, T. 27 N., R. 15 E., drilled in 1954

Britton and Lane No. 1 Conners, sec. 23, T. 23 N., R. 19 E., drilled in 1961

Davis and Miller No. 1 Knight, sec. 34, T. 21 N., R. 21 E., drilled in 1959

Evans No. 2-A Penner, sec. 2, T. 22 N., R. 15 E., drilled in 1959

Northeastern Oil No. 1 Dickerson, sec. 12, T. 22 N., R. 18 E., drilled in 1958

Leonard and Carter No. 1 Highfill, sec. 5, T. 11 N., R. 21 E., drilled in 1954

Prairie Oil & Gas No. 3 Letts, sec. 23, T. 17 N., R. 9 E., drilled in 1923 (bottom samples from 4,321-4,344 feet)

It would be appreciated if anyone knowing the whereabouts of samples from these wells would write to Louise Jordan, Oklahoma Geological Survey, Norman, Oklahoma.

More Names for Fossils from Russia

We have just received a two-volume work titled *Novye vidy drevnikh rasteniy i bespozvonochnykh SSSR* (New species of fossil plants and invertebrates of the USSR). The books are dated 1960, but the printer's data in volume 1 indicate a 1961 date. The volumes are devoted to short articles in which new taxa are described and figured. Many authors are represented. Thirty-five nude specific names of earlier years are validated in the two volumes.

Volume 1, containing 612 pages and 92 plates, gives descriptions of new fossil plants, foraminifers, corals, bryozoans, brachiopods, and minor groups. In the 103 articles are 308 new species and 13 new subspecies.

New major taxa are *Ursodendron* (p. 22) for a 1956 nude name of a lycopod, *Dichophyllites* Borsuk (p. 35) in Autophyllitaceae Radczenko [Radchenko]* new family (should be Autophyllitidae), *Chacassopteris* Radczenko (p. 45) (for *Khacassopteris* Radczenko, nude name of 1955), *Tomia* Srebrodolskaja [Srebrodol'skaya] (p. 81), *Tersiella* Radczenko (p. 118), *Triporoletes* Mtchedlishvili (p. 127).

New genera of Foraminifera are *Eoendothyra* M.-Maclay [Miklukho-Maklay] (p. 140), *Quasiarchaediscus* M.-Maclay (p. 150), and *Pseudotristix* K. M.-Maclay, subgenus of *Tristix* (p. 156), a nude name of 1958.

New genera of rugose corals are *Neobrachyelasma* Nikolaieva [Nikolaeva] (p. 220); *Orthopaterophyllum* (p. 221), attributed to Nikolaieva 1935 but obviously a new genus because the type species is described here (the generic name was used by Bulvanker in 1952, probably as a nude name); *Altaja* Zheltonogova (p. 226), a Silurian genus; *Pseudodigonophyllum* Spassky [Spasskiy] (p. 236), Eifelian; and *Zmeinogorskia* Spassky (p. 238), Middle Devonian.

The new bryozoan genus *Pseudocampylus* Troizkaja [Troitskaya] (p. 258) is Devonian; *Fenestella granulifera* Nekhoroshev (p. 272) is a still-born homonym of *Fenestrellina granulifera* Crockford, 1941; *F. microtuberculata* Nekhoroshev (p. 273) is a still-born homonym of *F. lahuseni microtuberculata* Shulga, 1941; and *Sibiredictya* Nekhoroshev (p. 277) is Middle Ordovician.

Of brachiopods, *Altorthis* Andreeva (p. 288); *Alimbella* Andreeva (p. 293), the type of a new family, Alimbellidae; and *Medessia* Andreeva (p. 295) are Ordovician. *Leviconchidiella* Rzonsnitzkaja [Rzhonsnitskaya] (p. 301), *Urella* Rzonsnitzkaja (p. 402), and *Nuguschella* Tjazheva [Tyazheva] (p. 408) are Middle Devonian. *Stepanoviella* Zavodowsky [Zavodovskiy] (p. 336) is Permian.

Volume 2 contains 522 pages and 70 plates, and there are 61 articles on new arthropods, mollusks, and crinoid columnals. *Pseudoconocardium* Zavodowsky [Zavodovskiy] (p. 31) is here judged to be *Conocardium*. M. K. Elias has translated the description and no evidence

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*Transliterations of Russian authors' names are as given in the Russian book. Where these differ from the transliteration derived through the system accepted by the U. S. Government Printing Office, the GPO-derived transliteration is given in brackets.

of the distinctive hingement shown in text-figure 2 is presented; the photographs (pl. 6, figs. 1a-1d, 2) appear to be of normal *Conocardium* with rostrum and gape. *Arctotis* Bodylevsky [Bodylevskiy] (p. 44) is based upon a nude name of 1957, now validated.

The nautiloids *Talassoceras* Balaschov [Balashov] (p. 123) and *Tallinoceras* Balaschov (p. 126) are Middle Ordovician. The new suborder Intejoceratina Balaschov (p. 128) contains the new family Intejoceratidae Balaschov (p. 129), and new genera *Intejoceras* Balaschov (p. 130) and *Evenoceras* Balaschov (p. 131), both Ordovician, and the new family Padunoceratidae Balaschov (p. 133), new genus *Padunoceras* Balaschov (p. 133) of the Middle Ordovician. The new genus *Ellinoceras* Balaschov (p. 135) is Middle Ordovician. *Procolumbites* Bajarunas [Bayarunas] (p. 141), a nude name of 1936, is for a Triassic genus. *Subdoricranites* Bajarunas (p. 158), replacing a 1936 nude name, is Triassic.

Among the ammonoids, *Primoryites* Chudoley [Khudoley] (p. 163) is Tithonian in age. *Astieriptychites* Bodylevsky [Bodylevskiy] (p. 172) is a genus based upon a 1957 nude name, here validated from the Lower Cretaceous of Siberia. *Paramegateuthis* Gustomesov (p. 190) is a new subgenus of Callovian age. *Spanioteuthis* Gustomesov (p. 207) is from the Middle Callovian.

Inikanella Lermontova (p. 222) and *Bolaspidina* Lermontova (p. 241) are Middle Cambrian trilobite genera. *Kuraspis* N. Tchernysheva [Chernysheva] (p. 250) is Upper Cambrian to Lower Ordovician from Siberia. *Schizoproetus,* listed as a new genus on page 257, is a genus of Richter, and the label "gen. nov." is probably incorrect. *Dechenellurus* Z. Maximova [Maksimova] (p. 259) is based upon a species from the Coblentzian of Kazakstan, and three of Hall's species are referred to the genus.

The ostracod genus *Costoprimites* V. Ivanova (p. 292) is from Ordovician rocks. *Glandites* V. Ivanova (p. 296) is established in the new family Glanditiidae (should be Glanditidae). *Ivanoviella* (p. 300) is established by V. A. Ivanova in honor of E. A. Ivanova for a Middle Ordovician ostracod genus. *Ochesaarina* Neckaja [Netskaya] (p. 309) occurs in Silurian rocks. *Moierina* Abushik (p. 322) is a Silurian genus. *Pseudozygobolbina* Neckaja (p. 324) is known only from the Ludlovian. The new genus *Pseudorayella* Neckaja (p. 360) is Ordovician and Silurian. *Schneideria* Kotschetkova [Kochetkova] (p. 362) is Kazanian and Tatarian.

The new taxa are distributed as follows:

	NEW GENERA	NEW SPECIES	NEW SUBSPECIES
Plants	6	73	3
Foraminifera	3	26	1
Porifera	0	1	0
Anthozoa	4	76	3
Conulariida	0	3	0
Bryozoa	2	27	0
Brachiopoda	8	112	5
Gastropoda	0	1	0
Bivalvia	1	97	8

Cephalopoda	12	67	0
Trilobita	5	40	4
Ostracoda	8	98	0
Crinoidea	0	5	0
Graptolithina	0	4	0

The stratigraphic distribution of the species is as follows:

Tertiary	20
Cretaceous	50
Jurassic	66
Triassic	41
Permian	81
Carboniferous	47
Devonian	195
Silurian	98
Ordovician	44
Cambrian	32

The facts that few species are well illustrated and that the books have no stratigraphic or taxonomic unity will make the publication difficult to use.

The volumes were issued by the Vsesoyucznyy Nauchno-issledovatel'skiy Geologicheskiy Institut (VSEGEI).

—C. C. B.

Marine Fossils from Coal Beds

Marine fossils occur in coal balls with calcified or pyritized plant remains. Coal balls are concretions which contain fossil plant material replaced by and surrounded by mineral matter and which occur in coal beds. They are little known in rocks other than Pennsylvanian bituminous coals.

Mamay and Yochelson report coal balls from the Secor coal at Chambers, Pittsburg County, Oklahoma, and in these they identified Foraminifera, annelids, bryozoans, phosphatic brachiopods, many types of clams and snails, a cephalopod, a trilobite, ostracodes, shark and bony fish remains, conodonts, and spores. Other coal ball collections from which marine fossils were recovered were made in Kansas (three localities), Iowa, and Illinois.

The book is *Occurrence and significance of marine animal remains in American coal balls,* by S. H. Mamay and E. L. Yochelson, U. S. Geological Survey, Professional Paper 354-I, pages 193-224, plates 26-34, figures 42-45, 1962. It is obtainable from the Superintendent of Documents, Washington 25, D. C., for fifty cents.

—C. C. B.

Symposium on Salt

The Northern Ohio Geological Society, organized in 1961, sponsored a symposium on salt, May 3-5, 1962, at the Manger Hotel, Cleveland, Ohio. The meeting was divided into three sections: Geology; Mining, Evaporated Salt; and Solution Mining, Underground Storage. The sections met concurrently and during two days 65 papers were presented. Some 350 research, petroleum, and economic geologists; mining, chemical, and industrial engineers; and other related professionals attended the meetings.

Groups visited the Morton Salt Company's 2,000-foot mine and its plant at Fairport about 20 miles east of Cleveland and the Diamond Crystal Salt Company's salt evaporating plant at Akron. Salt at each place is obtained from the Salina Group of Silurian age.

Papers presented at the Geology Section were as follows:

Origin of salt deposits, by K. K. Landes

Silurian of New York State, by W. L. Kreidler

Stratigraphy of Cayugan Series in northwestern Pennsylvania, by A. S. Cate

Distribution of salt in Ohio, by J. F. Hall

Evaporite facies in northwestern Ohio, by F. G. Stehli, J. N. Namy, and M. D. Aten

Clay mineral composition of the evaporite sequences, by J. Droste

Deposition of evaporites in the Michigan basin, by L. I. Briggs

Clay mineralogy of the Salina sequence, by L. F. Lounsbury

Effects of solution of bedrock salt in the earth's crust, by K. K. Landes

Environment and mechanics of deposition of the Permian Hutchinson Salt Member of the Wellington Shale, by L. F. Dellwig

Chemistry of brine inclusion in Permian salt from Hutchinson, Kansas, by W. T. Holser

Fossil content of salt and association evaporites, by P. Tasch

Geology of Gulf Coast salt domes, by G. E. Murray

Structure of the salt in Gulf Coast domes, by D. H. Kupfer

Permian salt deposits of southwest Texas and New Mexico, by J. E. Adams

Salt anticlines of the Paradox basin, Colorado and Utah, by D. P. Elston and E. M. Shoemaker

Salt deposits of the Williston basin—U. S. portion, by H. E. Reed

Virgin Valley salt deposits, Clark County, Nevada, by L. E. Mannion

Eocene salt in the Green River basin, Wyoming, by D. L. Deardorff

Salt deposits in desert basins of the western United States, by W. Smith

Salt deposits of Canada, by W. J. Pearson

Geochemistry of bromine in some salt rocks of the Prairie Evaporite Formation of Saskatchewan, by W. Schwerdtner and N. C. Wardlaw

Petrofabric analyses of some anhydrite rocks, by W. Schwerdtner

Salt deposits of Mexico, by J. P. Larios

World salt resources, by S. J. Lefond

Other papers presented in Sections II and III which may be of interest to petroleum geologists are:

Rotary drilling of large diameter vertical holes, by J. W. Bawcom

Development of continuous boring machines for salt and potash underground mining, by C. E. McWorter

Exploration by horizontal drilling at Avery Island, Louisiana, by Wm. Walden and C. H. Jacoby

Electrical resistivity surveys in salt mines, by L. Scharon

Dome mining: floor vs. roof extraction, by N. Nicola

Storage of radioactive waste in mine cavities, by E. G. Struxness

Dow Canada brine field at Sarnia, Ontario, by J. F. Gilbert

The Canadian Brine Limited brine field at Windsor, Ontario, by J. D. Mair

International salt brine field at Watkins Glen, New York, by C. H. Jacoby

Offset brine wells by directional drilling, by G. B. French

Salt solution mining by Pittsburgh Plate Glass at Natrium, West Virginia, by C. A. Giese

Diamond Alkali brine field at Mont Belvieu, Texas, by M. L. Moore

Sonar measurements of brine cavities, by A. J. Myers

Use and interpretation of well logs in salt, by R. G. Hamilton and R. N. M. Urash

Use of salt solution cavities for underground storage, by C. A. Bays

Operations and maintenance of underground storage, by S. G. Branyan

Salt cavern storage of LPG at Hutchinson, Kansas, and Lowell, Michigan, by Richard Crow

Papers presented will be published late in 1962 by the Northern Ohio Geological Society in a Salt Symposium volume.

Errata

Oklahoma Geology Notes, May 1962, volume 22, number 5

Page 127: Reference of figure 1 should be to *table IV*.
Page 131: In cutlines for figures 1-3, for *pedicle value* read *brachial valve* in each instance.

Ouachita Facies

The long-awaited volume by Flawn, Goldstein, King, and Weaver has been issued. The book contains 401 pages, 13 figures, and 15 plates. The title of the book, "The Ouachita System," is unfortunate. The Ouachita sequence of rocks is not a system, but a sedimentary facies and a structural type. Another defect is that the book is dated October 15, 1961. It was received here on May 4, 1962.

Goldstein wrote the section on the Oklahoma-Arkansas area (p. 21-48) and gave a wealth of detail on sedimentary petrography. Flawn (p. 49-81) described the Marathon and other areas with many new data from the subsurface. King speculated upon the subsurface data of the eastern area (p. 83-98). Flawn summarized the available information on the Ouachita facies in Mexico (p. 83-106). Flawn contributed information on the igneous and metamorphic rocks of the fold-belt (p. 107-124). Special problems were discussed by Flawn (p. 125-146). Weaver's section on clay minerals (p. 147-162) shows that the technique contributes information but solves no problems. Flawn's section on tectonics (p. 164-173) points out the unsolved problems. King speculated upon the history of the region (p. 175-190). Goldstein and Flawn (p. 191-195) analyzed economic possibilities. The appendix consists of a valuable compilation of well records (p. 211-361).

The book was issued as The University of Texas, Publication Number 6120. It is obtainable from Bureau of Economic Geology, The University of Texas, Austin 12, Texas, at a price of $4.00.

—C. C. B.

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