NEUTRALIZATION POTENTIALS OF SOME COMMON AND UNCOMMON ROCKS, AND SOME PITFALLS IN NP MEASUREMENTS

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Static tests of neutralization potentials of silicate and aluminosilicate minerals

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Abstract The acid-generating potential of rocks depends on their sulfur content and neutralization potential (NP). Fifty-five "monomineralic" samples have been assessed for their NP contributions and for the effect of compositional variations in mineral series. For a threshold value of 20 kg $CaCO_3$ equivalent per tonne of material, most rock-forming minerals, including pyroxenes, amphiboles, feld-

Introduction

In dealing with environmental aspects of the potential exploitation of mineral and coal deposits, such as the ongoing disposal of wastes at operating mines, the preparation for mine closure, and the remediation of abandoned sites, it is essential to predict the geochemical behavior of the wastes upon their exposure to weathering. Accurate forecasting of the short-term weathering reac-

Environmental Geology (2002), Vol 43, 1-17

OBJECTIVE

- Comparison of measured Sobek NP for common rocks *versus* NP calculated from quantitative mineralogy and NP of the individual minerals

- Why?
  - To test whether NP values (2002) for minerals/groups are reasonable
  - To establish NP magnitude expected for a rock type

MATERIALS

31 non-calcareous rocks purchased (accessibility)

- Igneous intrusive (12)
- Igneous extrusive (6)
- Sedimentary (5)
- Metamorphic (8)

METHODS

- Standard Sobek tests
- Quantitative mineralogy using Rietveld processing of X-ray data
- Optical mineralogy
  - to assist XRD identifications
  - to detect small amounts of carbonates
- Select NP values for minerals/groups

AMPHIBOLE GROUP

Mineral	NP	Surface Area
Anthophyllite	4.0	3.247
Grunerite	8.2	2.780
Tremolite	5.2	1.23
Actinolite	1.5	0.455
Actinolite	2.5	0.306
Actinolite	0.7	0.256
Glaucophane	4.3	1.048
Pargasite	4.4	0.34
Ferropargasite	3.5	0.257
‘Fluoro-edenite	1.7	0.228
‘Fluoro-ferro-eckermannite”	0.2	0.093
“sodicgrunerite”	8.7	19.146

Selected: NP = 3

SELECTED SOBEK NP VALUES

Mineral/group	NP	Mineral/group	NP
quartz	0	garnet	3-6
K-feldspar	1	olivine	38
plagioclase		serpentine	19
albite, An_{0-50}	1-5	talc	2
anorthite, An_{50-80}	6-10	magnetite	2
amphibole	3	nepheline	25
pyroxene	5	analcime	11
mica/muscovite	1	thompsonite	13
mica/biotite	8	calcite	1000
chlorite/clinochlore	6	dolomite	1084
		siderite	862

SOBEK TEST

1. Determine the fizz rating
   - nil; slight; moderate; strong
   - 20 mL 0.1 *M*; 40 mL 0.1 *M*; 40 mL 0.5 *M*; 80 mL 0.5*M*

   We tested @ -60 mesh and @ -6 mm

2. Add the volume/normality of acid in accordance with the fizz rating; 2 g sample

3. Heat to nearly boiling

CARBONATE DETECTION/FIZZ

Rock	Fizz	-6mm	PTS
1. biotite granite	slight	X	X
2. granodiorite	nil		
3. syenite	nil	X	
4. monzonite porphyry	nil	X	X
5. hornblende diorite	nil		X
6. diabase	nil		

CARBONATE DETECTION/FIZZ

Rock	Fizz	-6mm	PTS
7. hornblende gabbro	nil	X	X
8. gabbro	nil	X	X
9. anorthosite	slight	X	X
10. pyroxenite	nil	X	X
11. peridotite	nil	X	X
12. andesine [gabbro]]	nil	X	X

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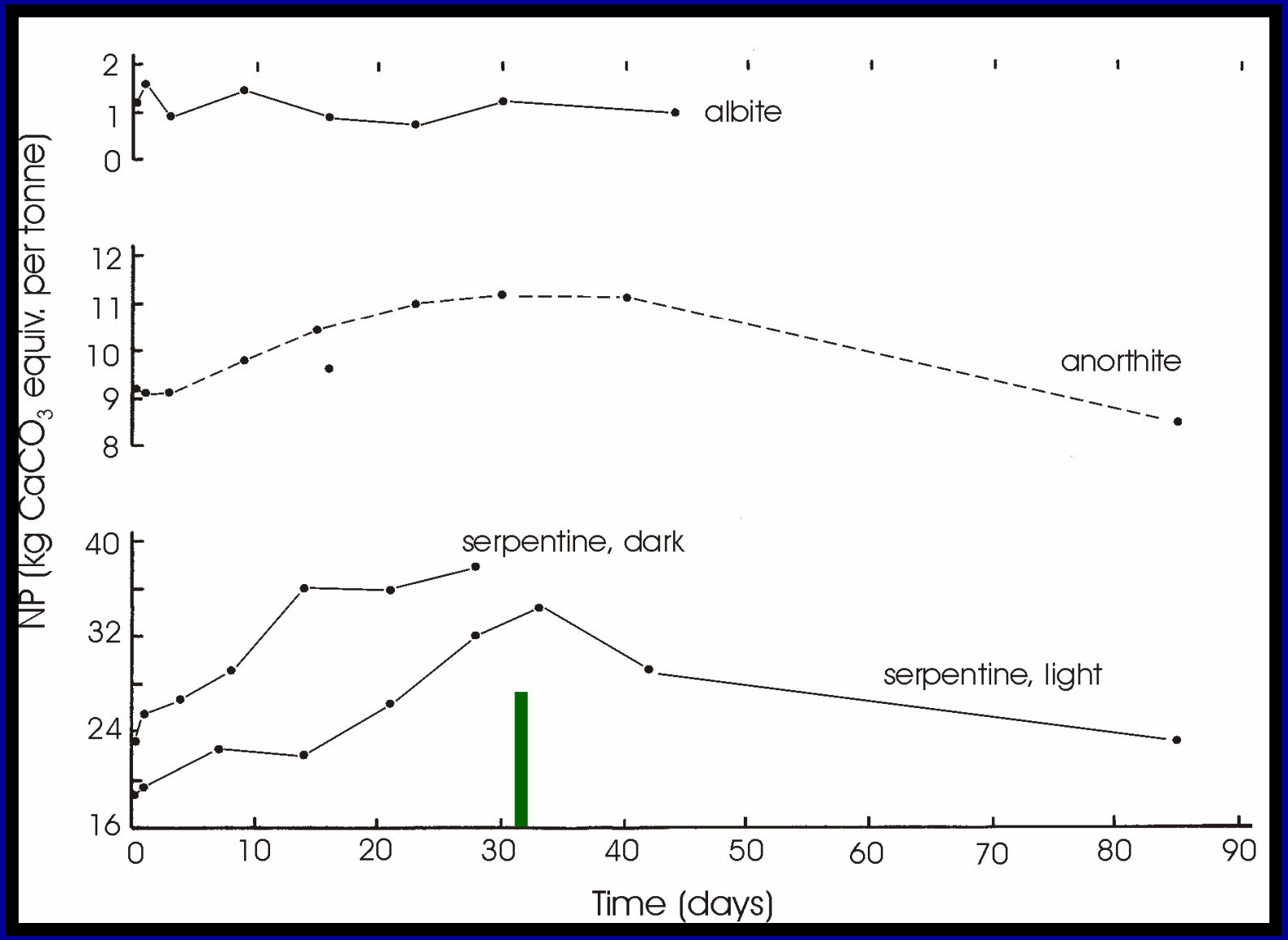
HEAT TO NEARLY BOILING

- method generally not specified
  - hotplate
  - water bath

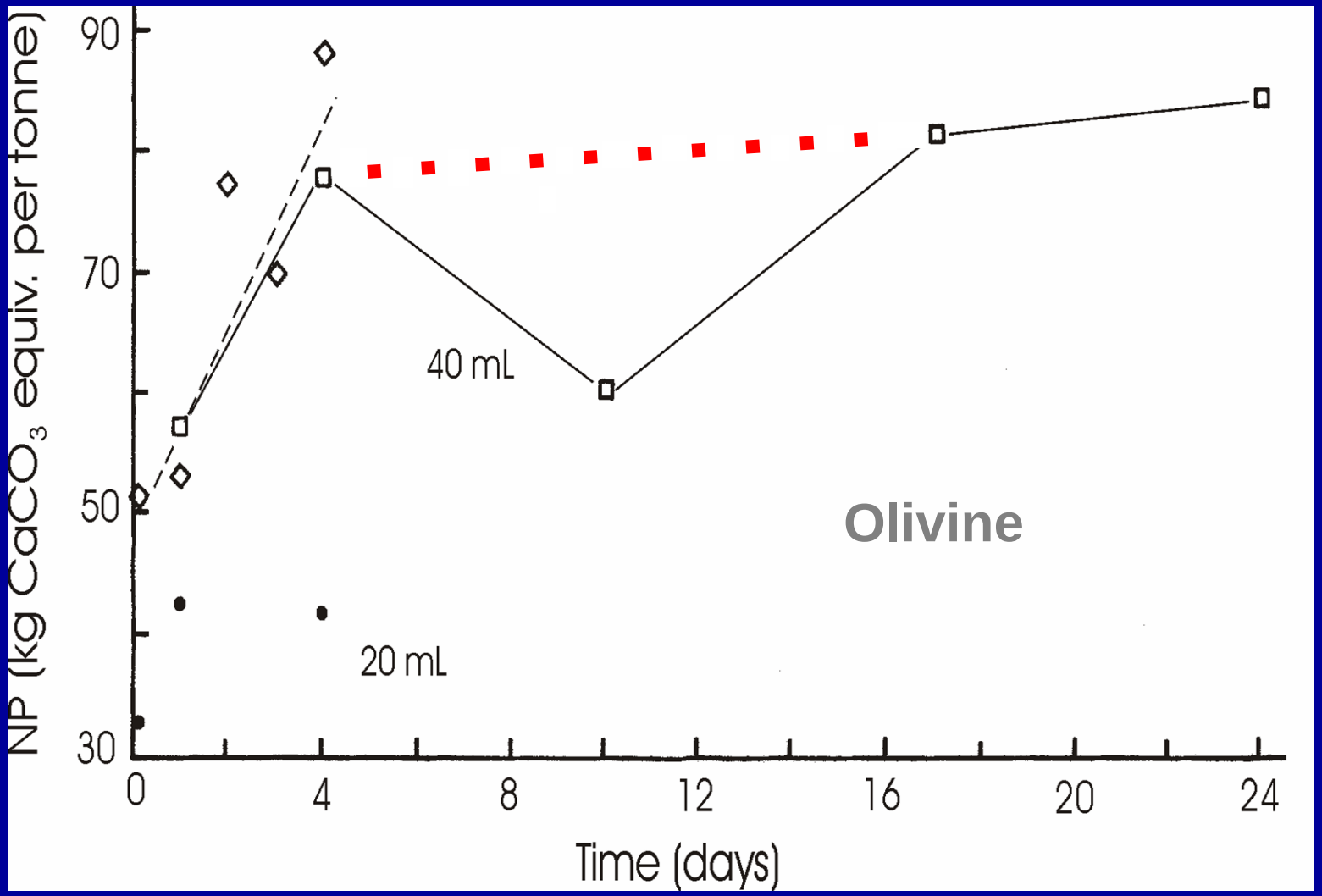
- time not specified
  - White et al. (1999): 1 hr @ 85°C
  - AMIRA (2002): 1 to 2 hr @ 80-90°C

- this study: water bath @ 90°C; 15 min.

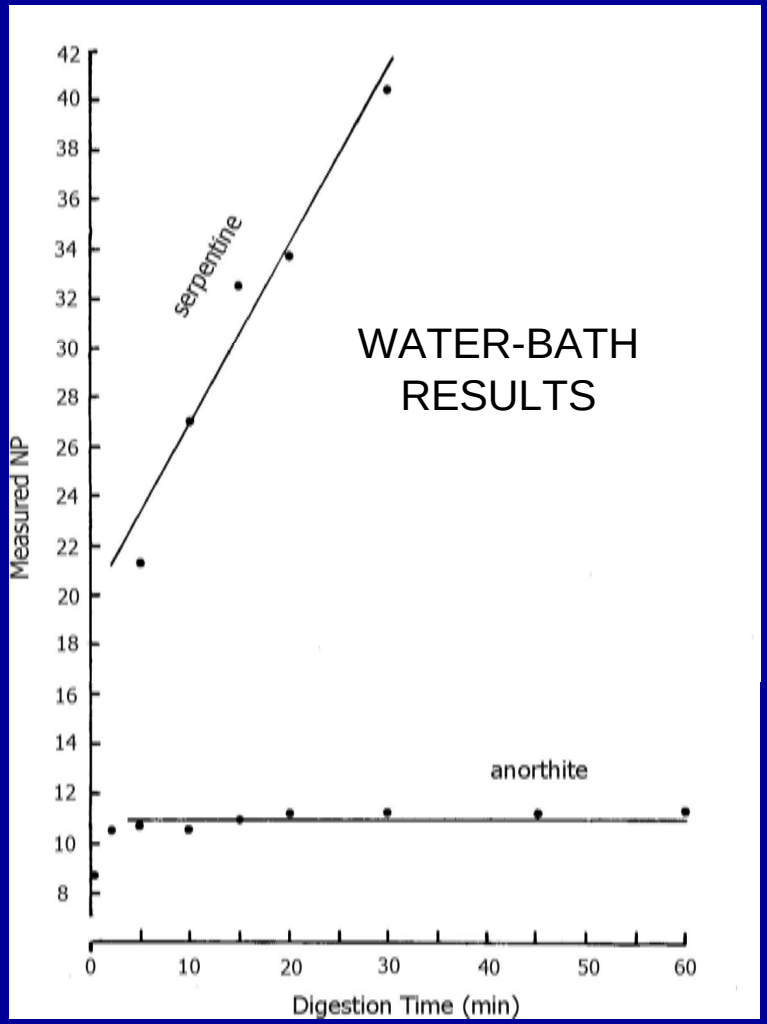
NP vs TIME


NP (kg $CaCO_3$ equiv. per tonne)
albite
anorthite
serpentine, dark
serpentine, light
Time (days)
2
1
0
12
11
10
9
8
40
32
24
16
0
10
20
30
40
50
60
70
80
90

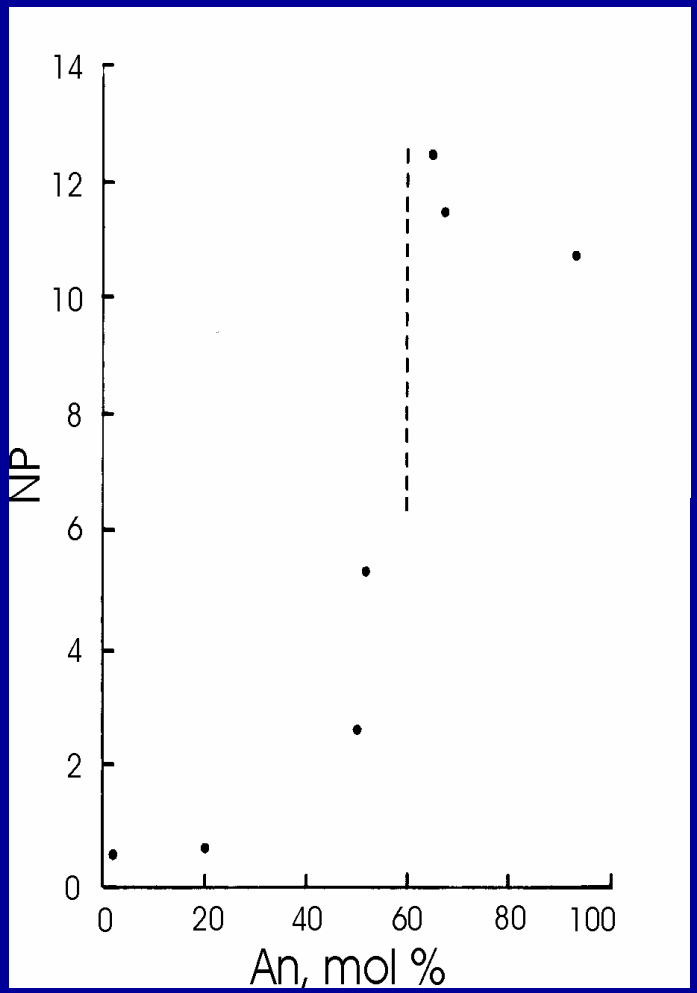
NP vs TIME


NP (kg $CaCO_3$ equiv. per tonne)
90
70
50
30
40 mL
20 mL
Olivine
0
4
8
12
16
20
24
Time (days)

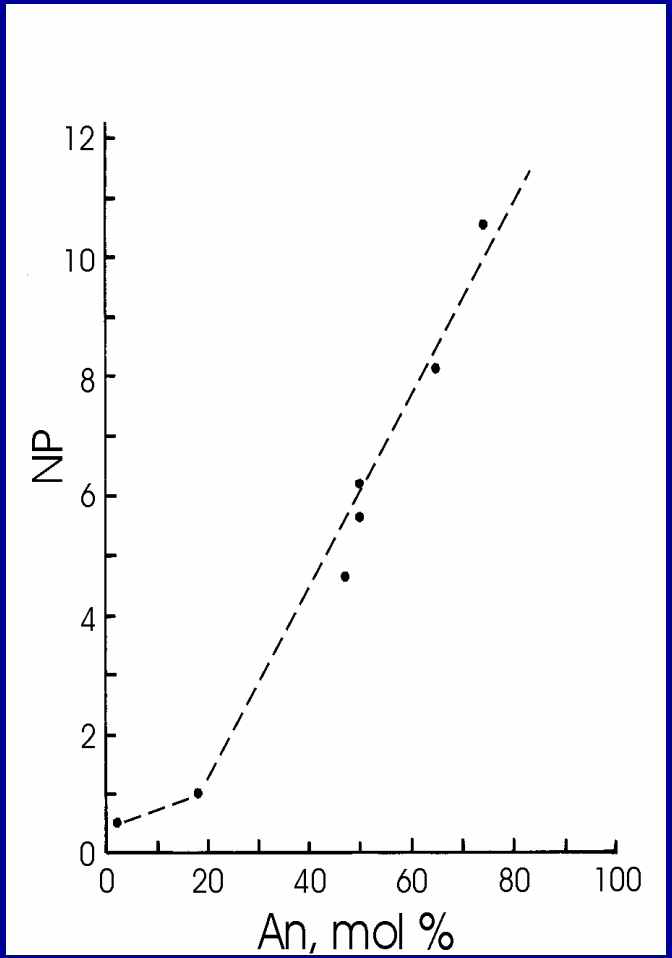
NP vs DIGESTION



MINERALOGICAL NP (plagioclase)



PLAGIOCLASE COMPOSITION vs NP



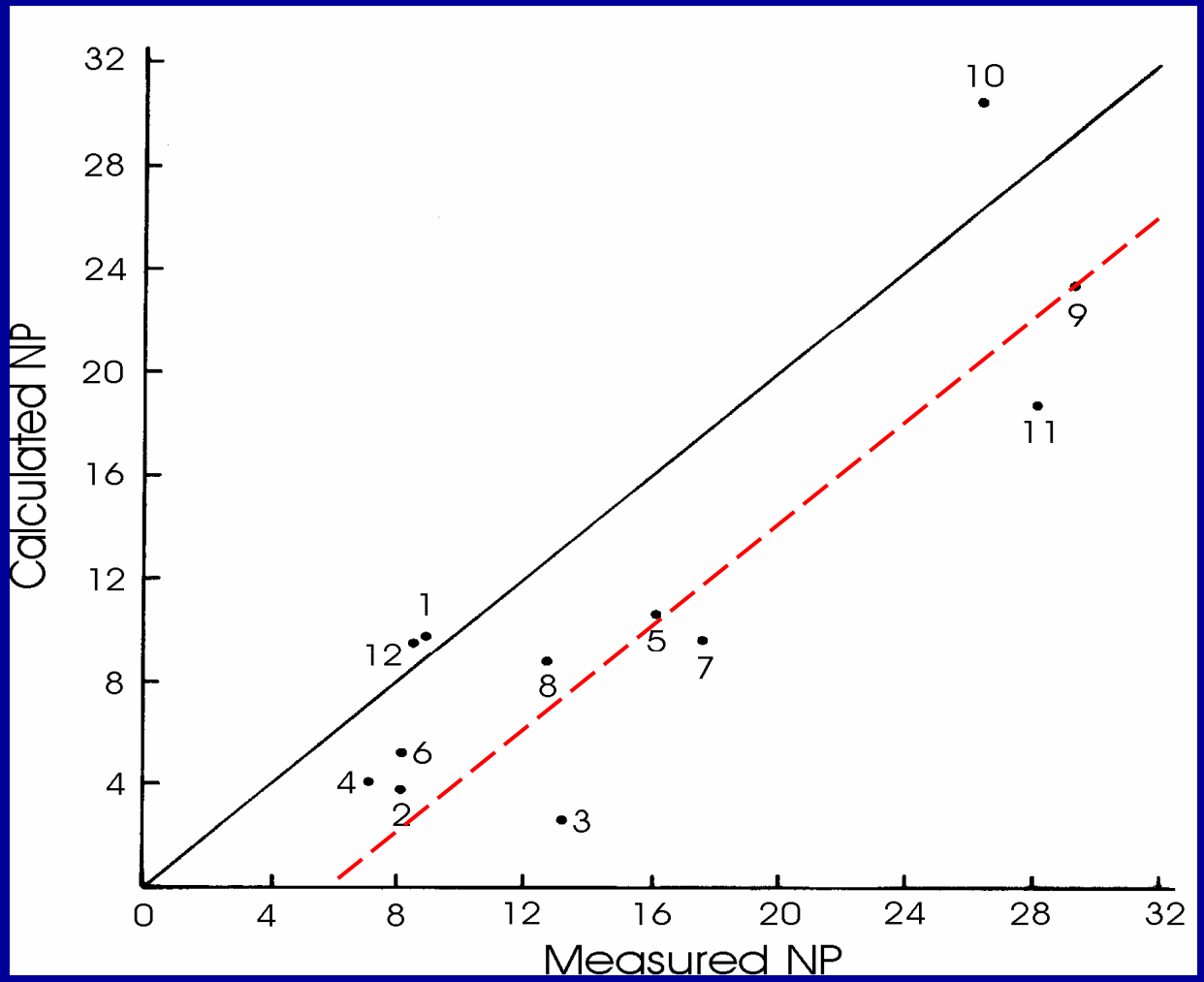
MEASURED vs CALCULATED NP

	NP_{meas}	NP_{calc}	Main NP Sources
1. granite	8.9	9.8	calcite
2. granodiorite	8.1	3.8	calcite
3. syenite	13.2	2.6	nepheline
4. monzonite	7.1	4.1	calcite
5. hblde diorite	16.1	10.6	calcite
6. diabase	8.1	5.2	plagioclase

MEASURED vs CALCULATED NP

	NP_{meas}	NP_{calc}	Main NP Sources
7. hblde gabbro	17.5	9.6	plagioclase
8. gabbro	12.7	8.7	plagioclase
9. anorthosite*	29.3	23.4	calcite, plagioclase
10. pyroxenite	26.3	30.4	olivine
11. peridotite	28.1	18.7	calcite, olivine, serp.
12. ‘andesine’	8.5	9.5	plagioclase, calcite

MEASURED vs CALCULATED NP



Except for plagioclase, no adjustments to NP of minerals

GREATEST DIVERGENCES

#3 SYENITE:

- weird rock; nepheline- and analcime-bearing
- reason not known

#7 HORNBLENDE GABBRO:

- plagioclase-dominant, but partly choritized
- wide range of An (29-54; *n* = 14)
- An content probably underestimated

#11 PERIDOTITE:

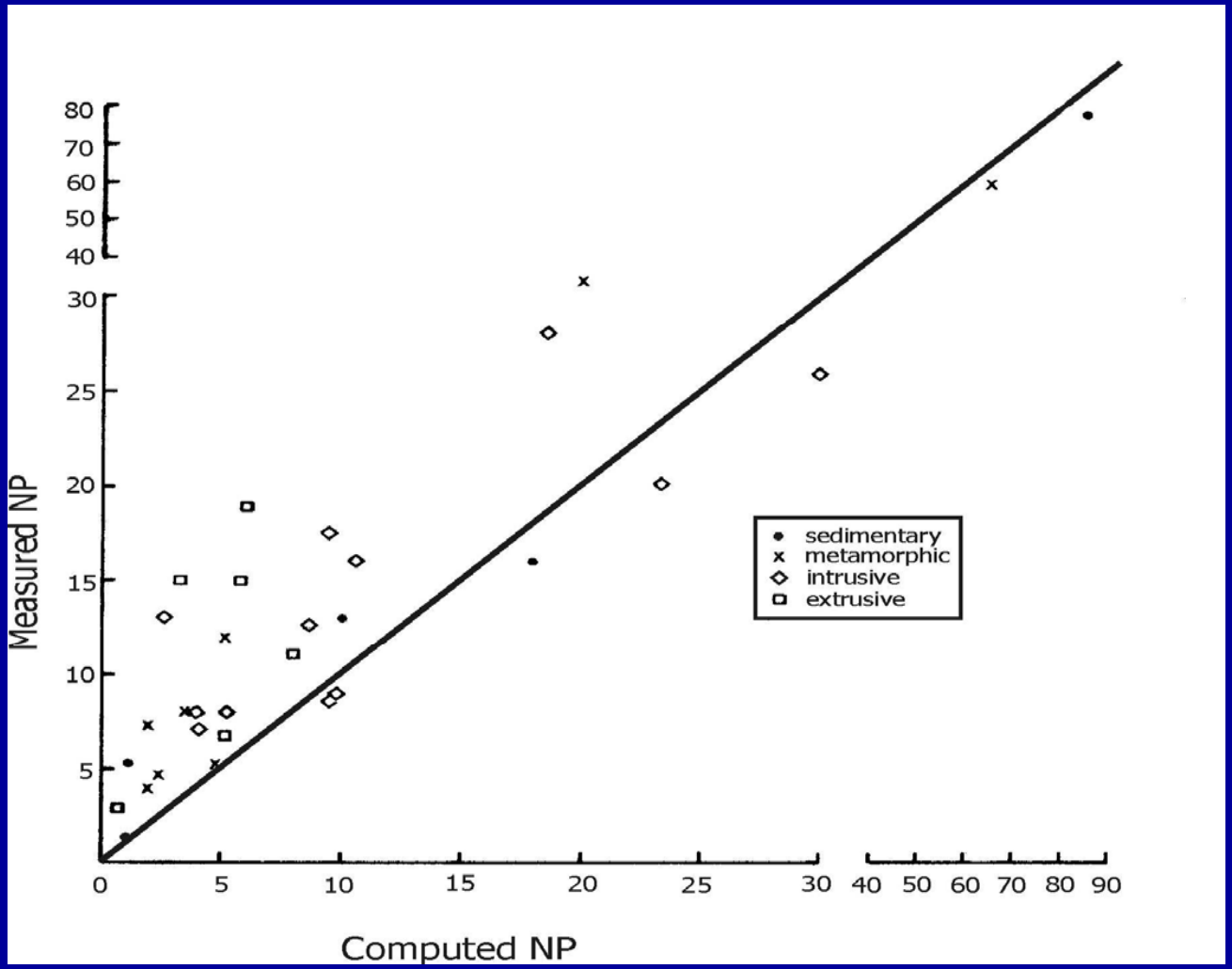
- uncertainty of NP values for olivine and serpentine (est. 38, 19 respectively)

GREATEST DIVERGENCES

#9 ANORTHOSITE:

- initially rated as ‘slight fizz’
- measured NP = 29.3 @ slight fizz;
  therefore, sample was over-acidified
- at corrected fizz rating, NP = 20.2

MEASURED vs COMPUTED NP



CONCLUSIONS

1) NP_{calc} (no adjustments other than for plagioclase) is typically lower than NP_{meas}

2) Of the 31 rocks examined, 12 have calcite or dolomite as the principal source of NP
   - 6 intrusive, 3 sedimentary, 3 metamorphic

3) Only 6 rocks gave NP > 20

CONCLUSIONS

4) Greatest divergences between NP_{calc} and NP_{meas}:

- rocks containing feldspathoids, or olivine + serpentine

5) Rocks containing olivine + serpentine require extra care in NP determinations

6) Sobek protocol needs to be specified better for acid-digestion stage (time + temperature)

FIZZ TEST

NP result itself indicates whether a sample has been over-acidified / under-acidified

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no fizz:	for samples up to NP = 50
slight fizz:	for samples with NP = 50 - 100
moderate fizz:	for samples with NP = 100 - 500
strong fizz:	for samples with NP = 500 - 1000

NP results not meeting these criteria should be discarded and the sample re-tested at the proper acidification.