U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
PANEL ON STRUCTURAL GEOLOGY & GEOENGINEERING

SUBJECT: PETROLOGY STUDIES: BASALT CYCLES

PRESENTER: DR. FRANK PERRY

PRESENTER'S TITLE AND ORGANIZATION: PRINCIPAL INVESTIGATOR, VOLCANISM STUDIES
UNIVERSITY OF NEW MEXICO

PRESENTER'S TELEPHONE NUMBER: (505) 277-6528

ALEXIS PARK HOTEL
SEPTEMBER 14 - 16, 1992

Geochemistry and Petrology Studies

1. Petrogenetic models
2. Constraints on physical models
3. Stratigraphic correlation

Eruption Models: Basaltic Volcanoes

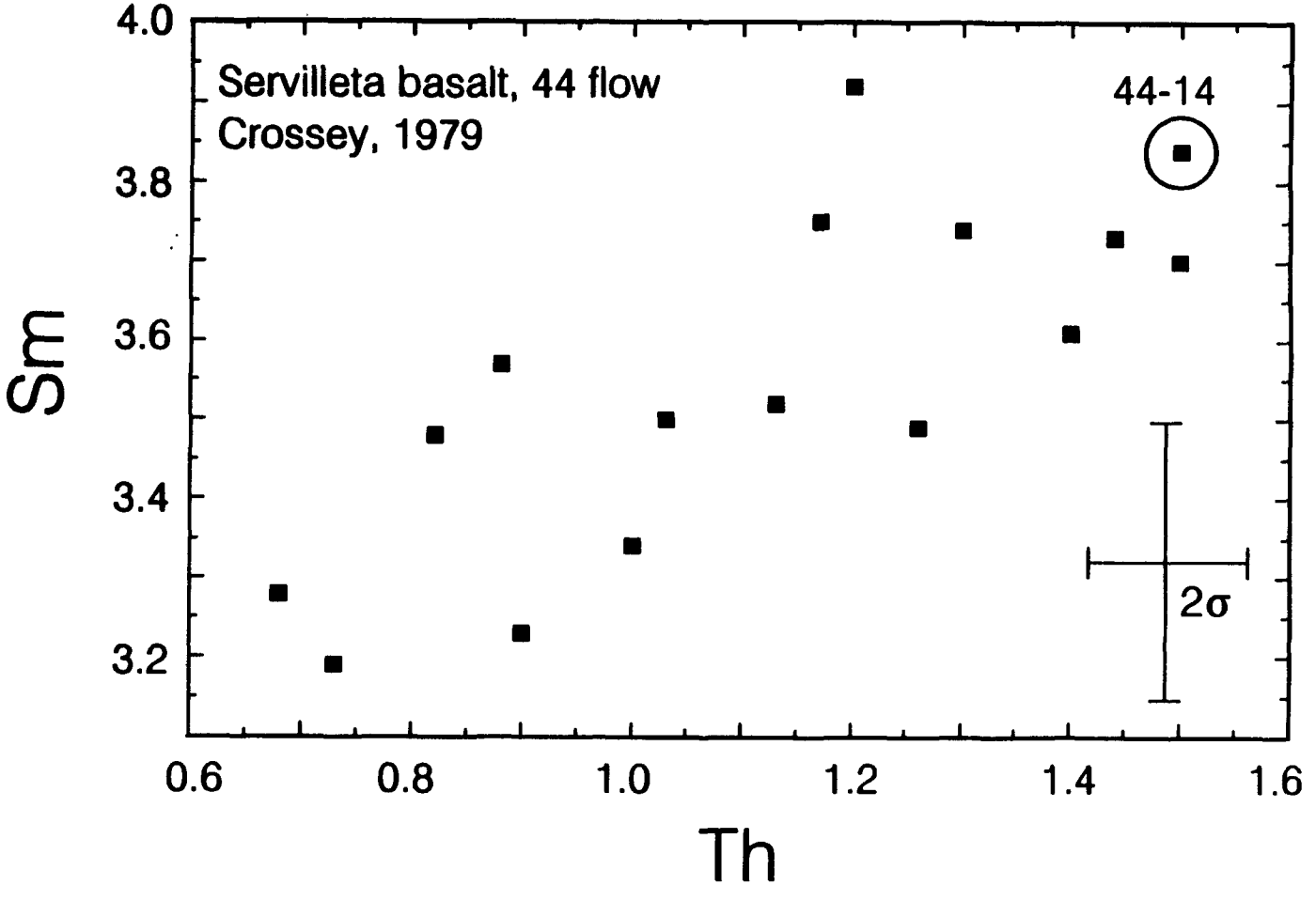
Monogenetic volcano

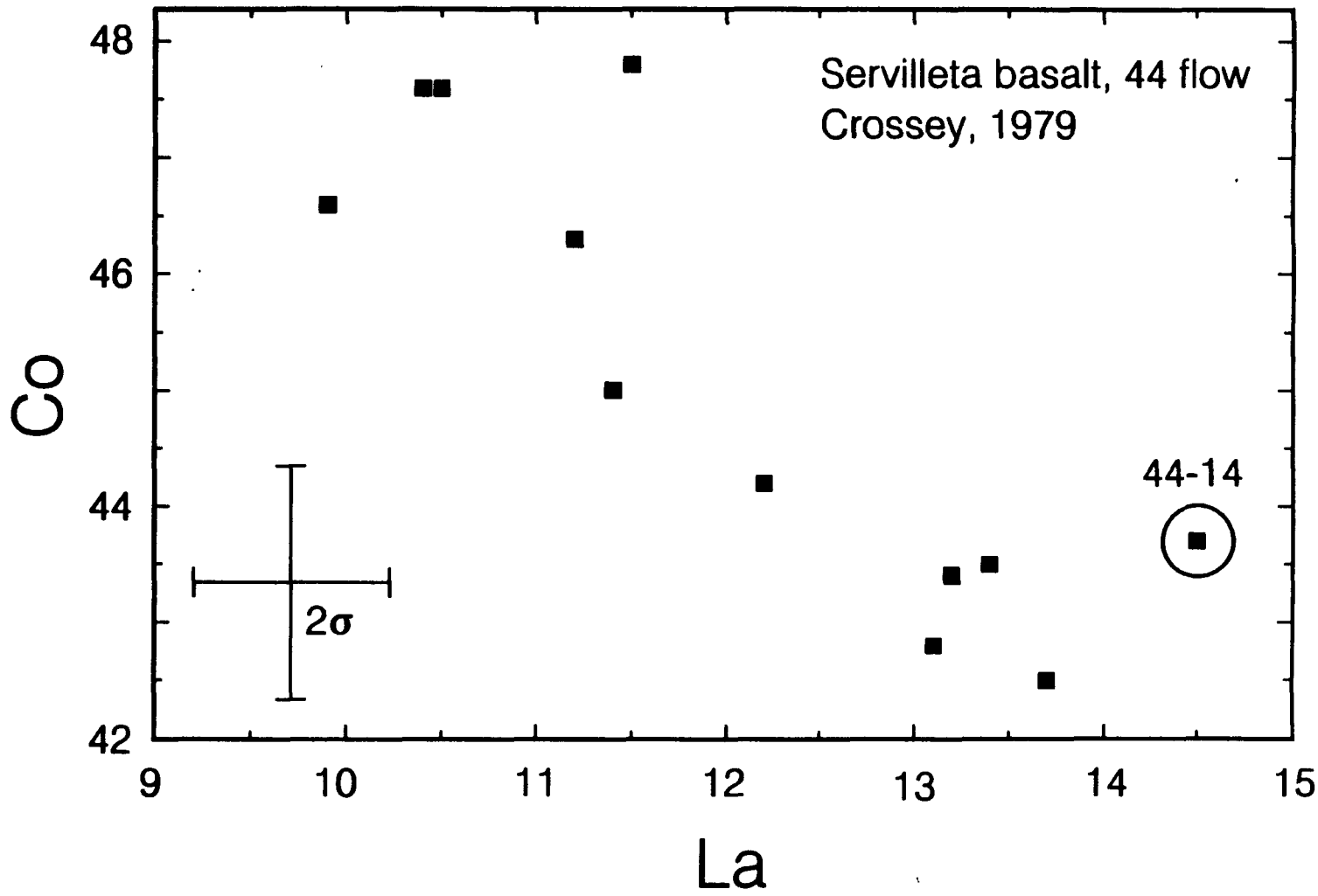
- Single, or closely spaced eruption phase
- Single batch of magma

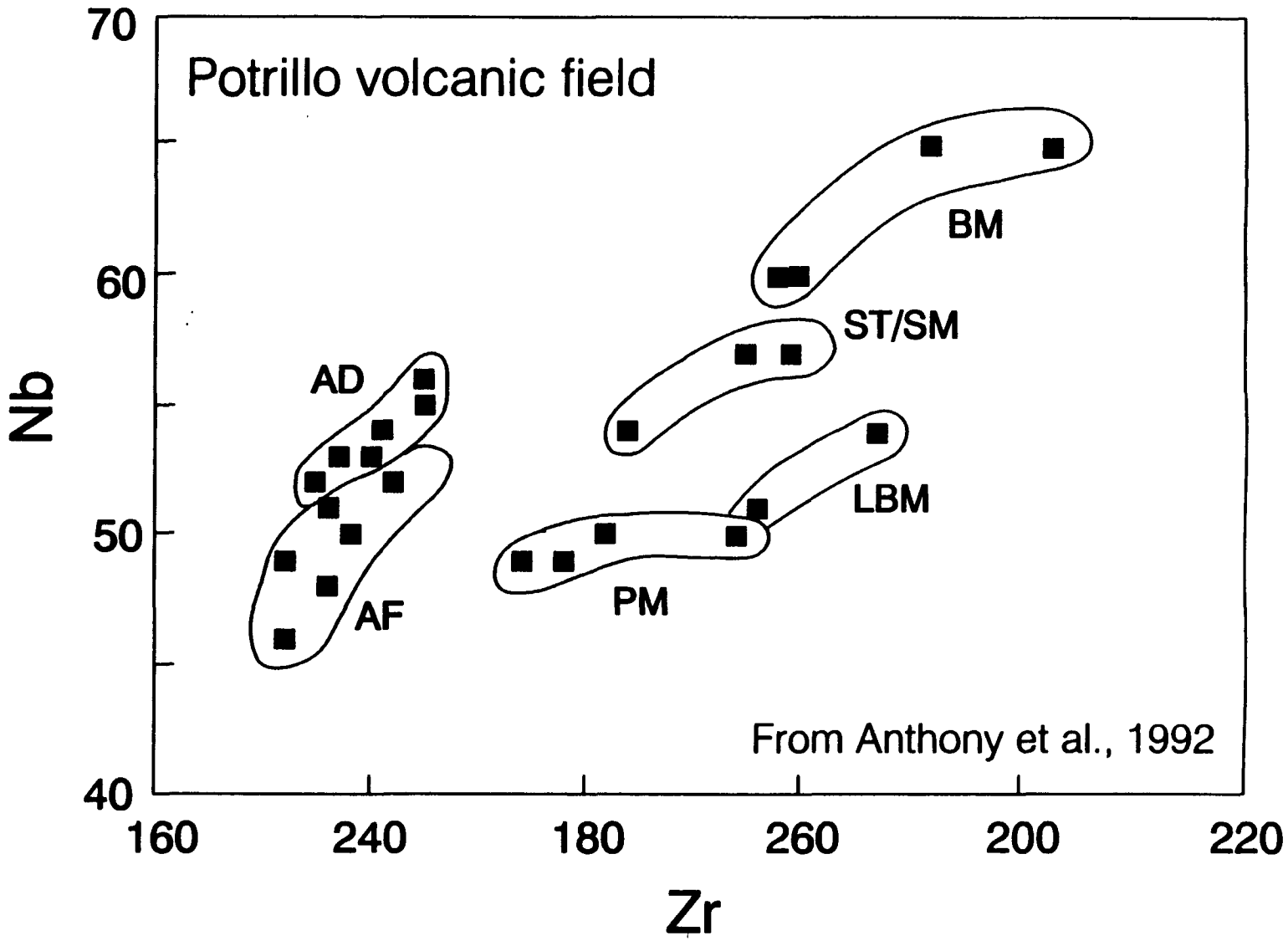
Polycyclic volcano

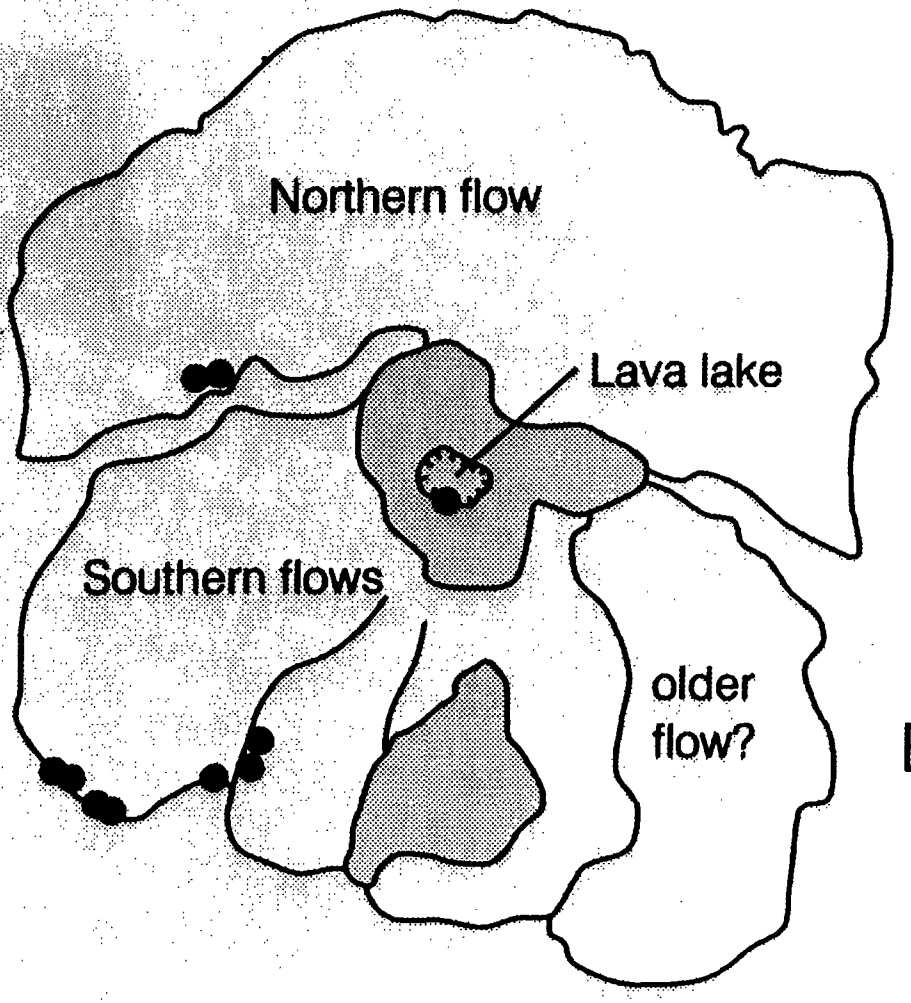
- Multiple eruption phases
- Multiple magma batches

Geochemical data can distinguish between a single or multiple magma batches

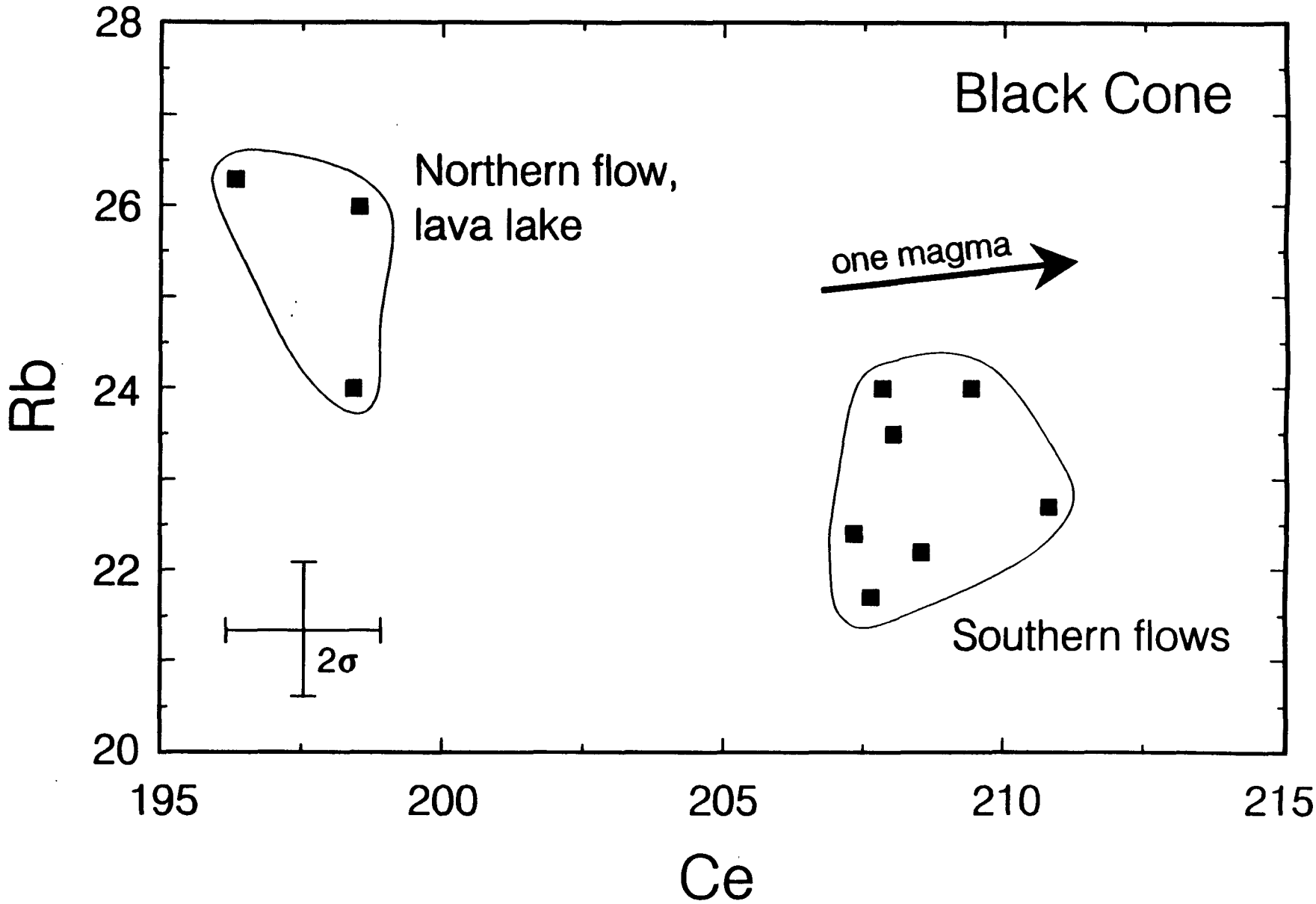

Servilleta basalt, 44 flow
Crossey, 1979
44-14
2σ
Sm
Th
4.0
3.8
3.6
3.4
3.2
0.6
0.8
1.0
1.2
1.4
1.6

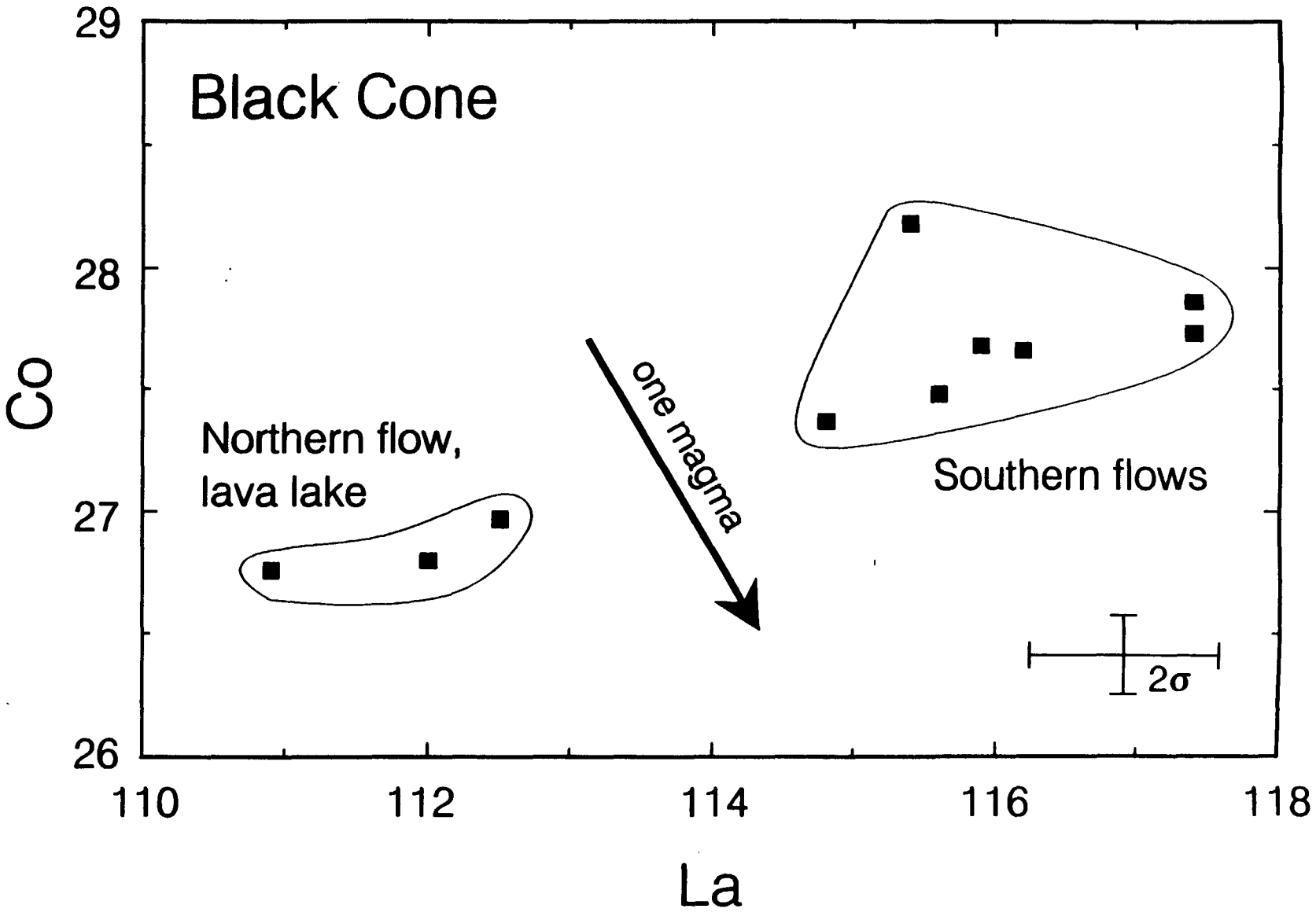

Servilleta basalt, 44 flow
Crossey, 1979
44-14
2σ
Co
La
48
46
44
42
9
10
11
12
13
14
15

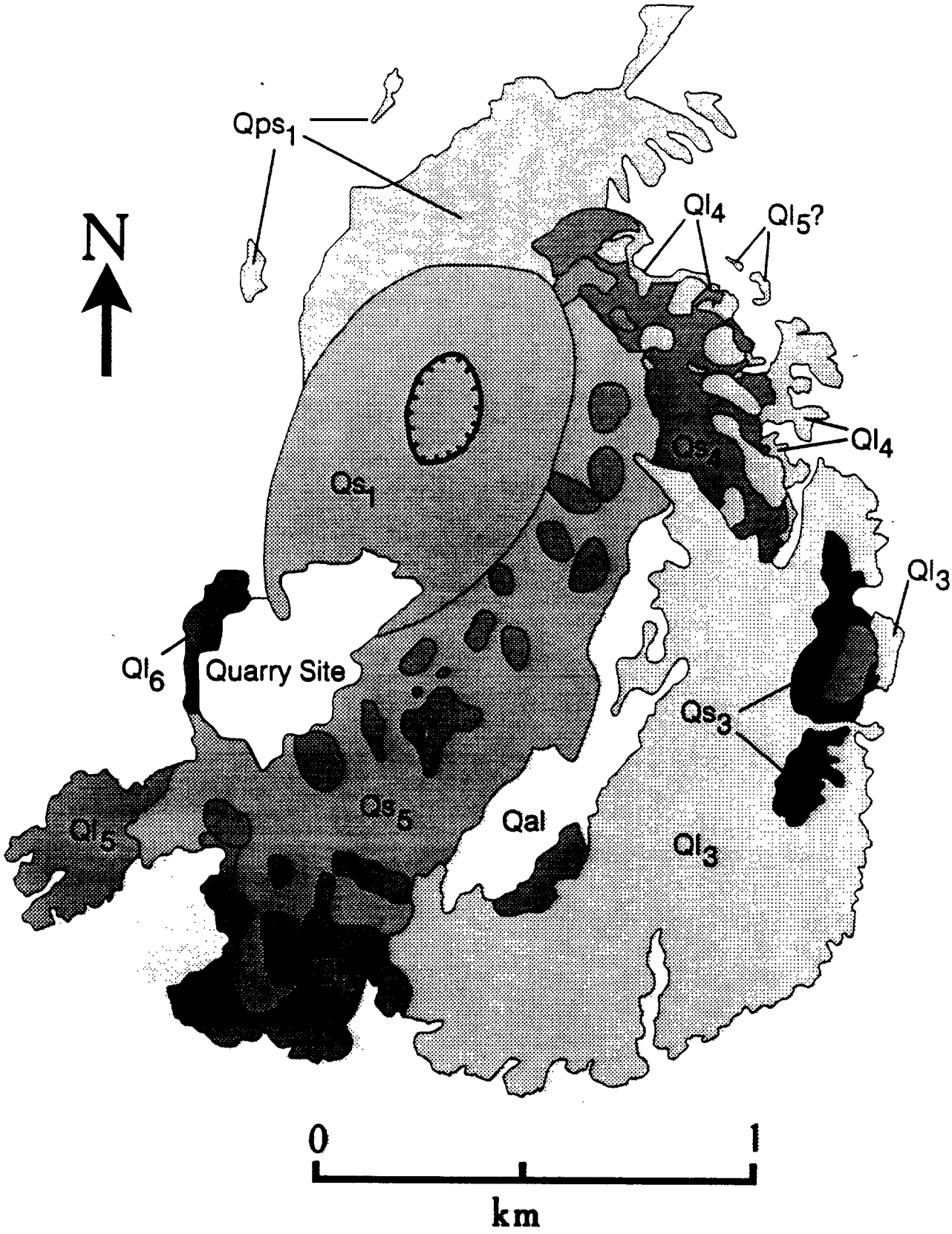

Potrillo volcanic field
BM
ST/SM
LBM
PM
AD
AF
From Anthony et al., 1992
70
60
50
40
Nb
160
240
180
260
200
220
Zr



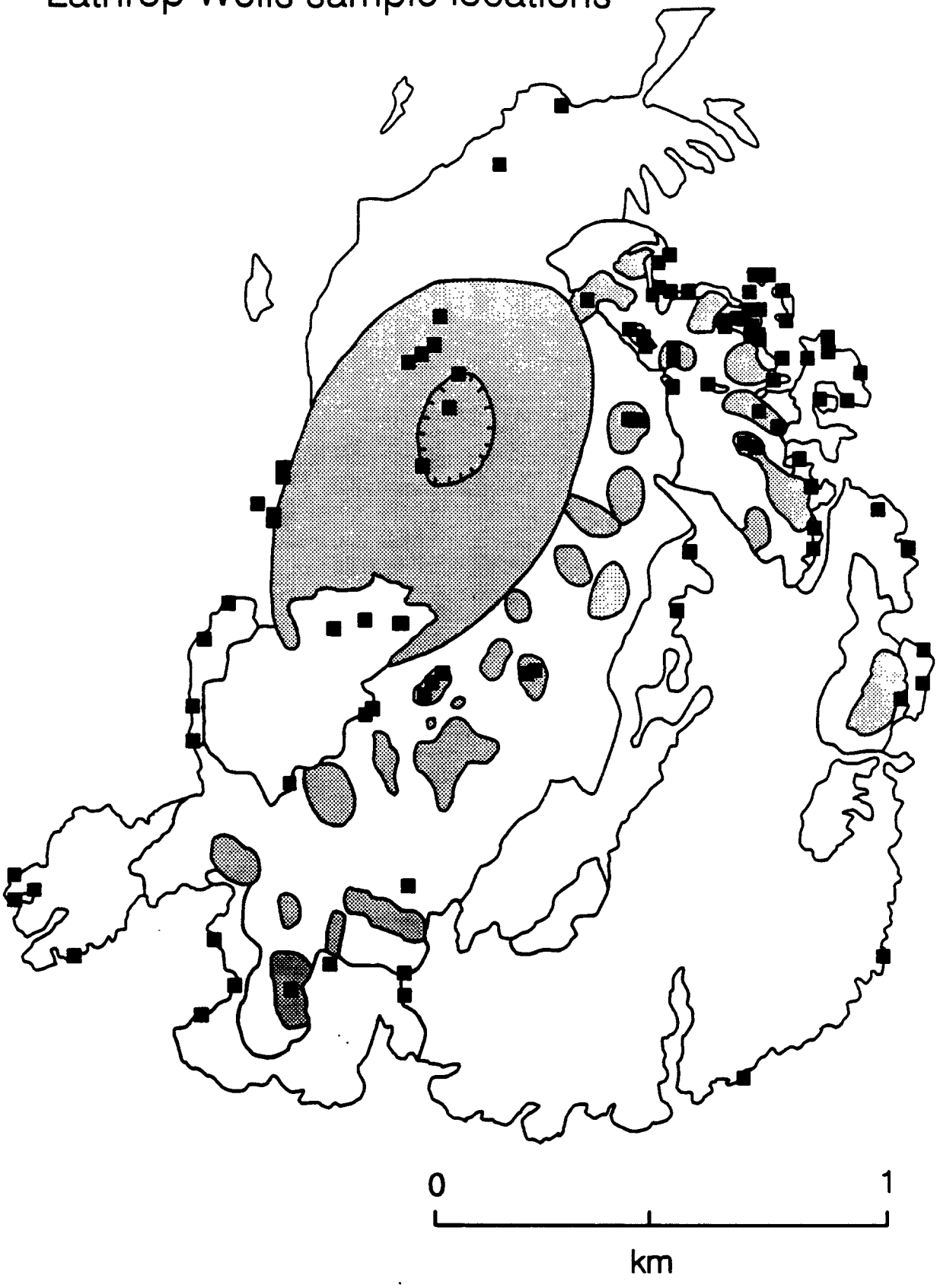
Black Cone
Center


Black Cone
Northern flow,
lava lake
one magma
Southern flows
2σ
Rb
Ce
28
26
24
22
20
195
200
205
210
215


Black Cone
Northern flow,
lava lake
one magma
Southern flows
2σ
Co
La
29
28
27
26
110
112
114
116
118


Qps1
N
Ql4
Ql5?
Ql4
Qs1
Qs1
Ql3
Ql6
Quarry Site
Qs3
Qs5
Qal
Ql5
Ql3
0
1
km

Lathrop Wells sample locations



Evidence for Multiple Magma Batches at Lathrop Wells:

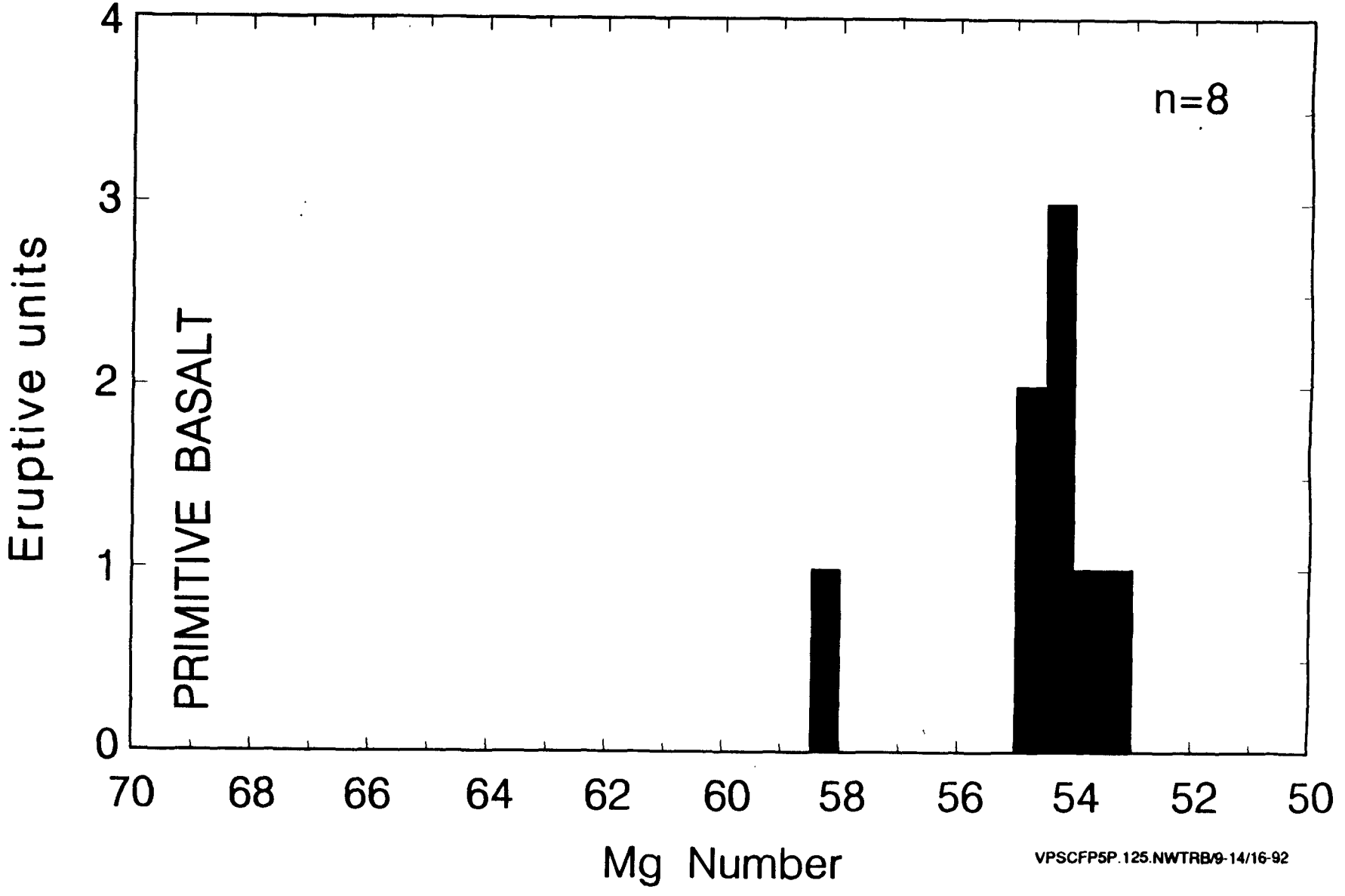
1. Petrography - distinct phenocryst assemblages
2. Geochemistry - trace elements, isotopes

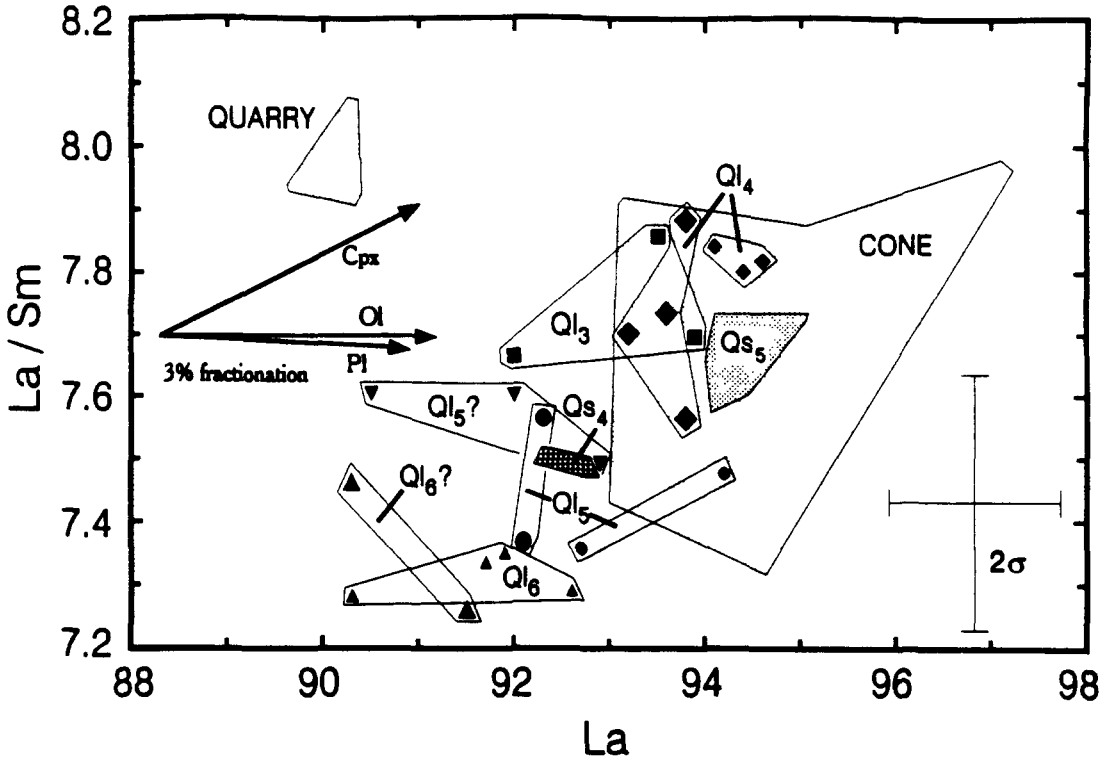
Photomicrographs of Lathrop Wells lavas

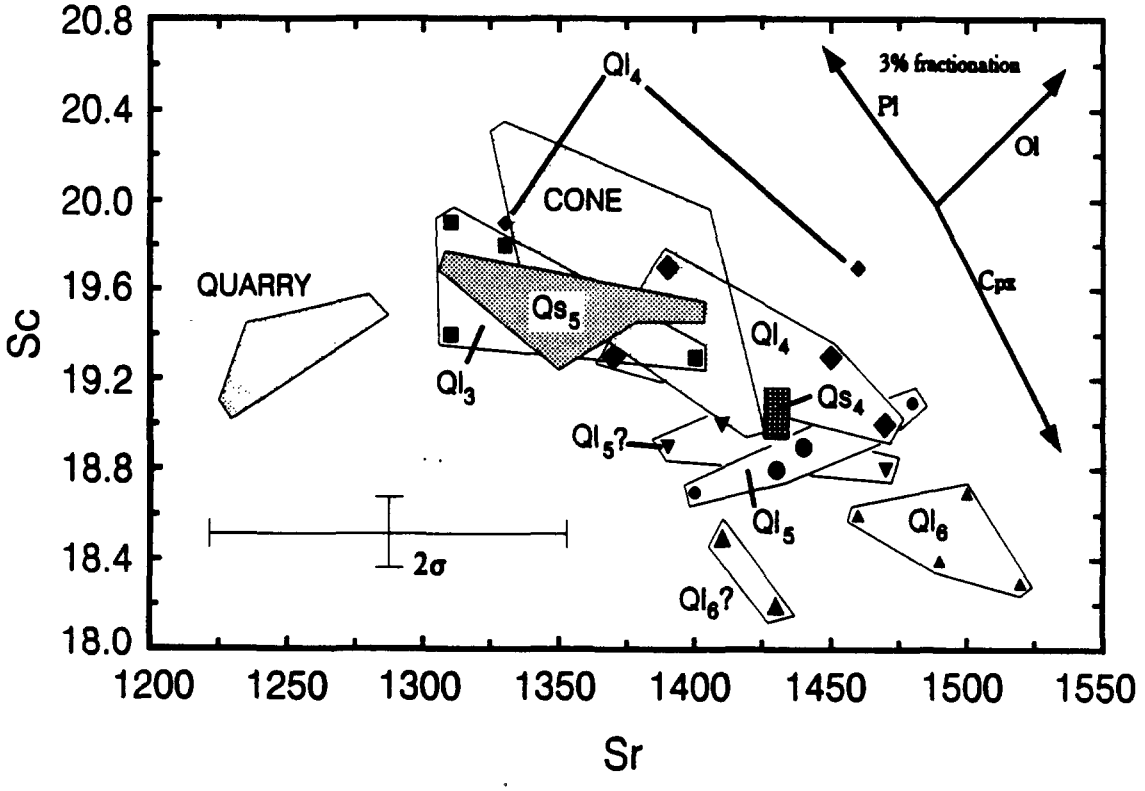
Evidence of Multiple Magma Batches

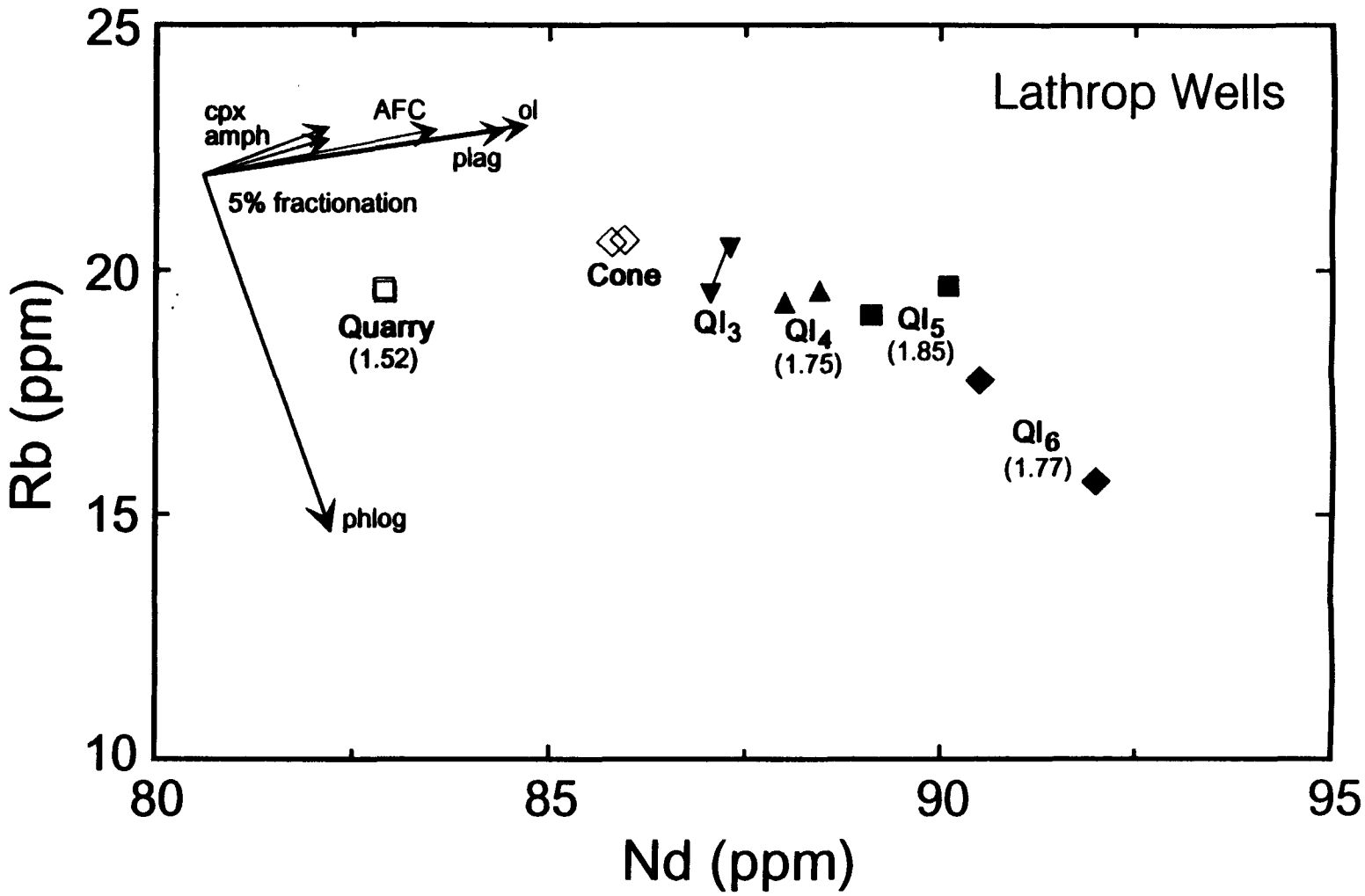
- **Changes in phenocryst assemblages, <u>without</u> associated changes in major and trace-element chemistry are inconsistent with a single magma batch (cf. Cerro Negro)**

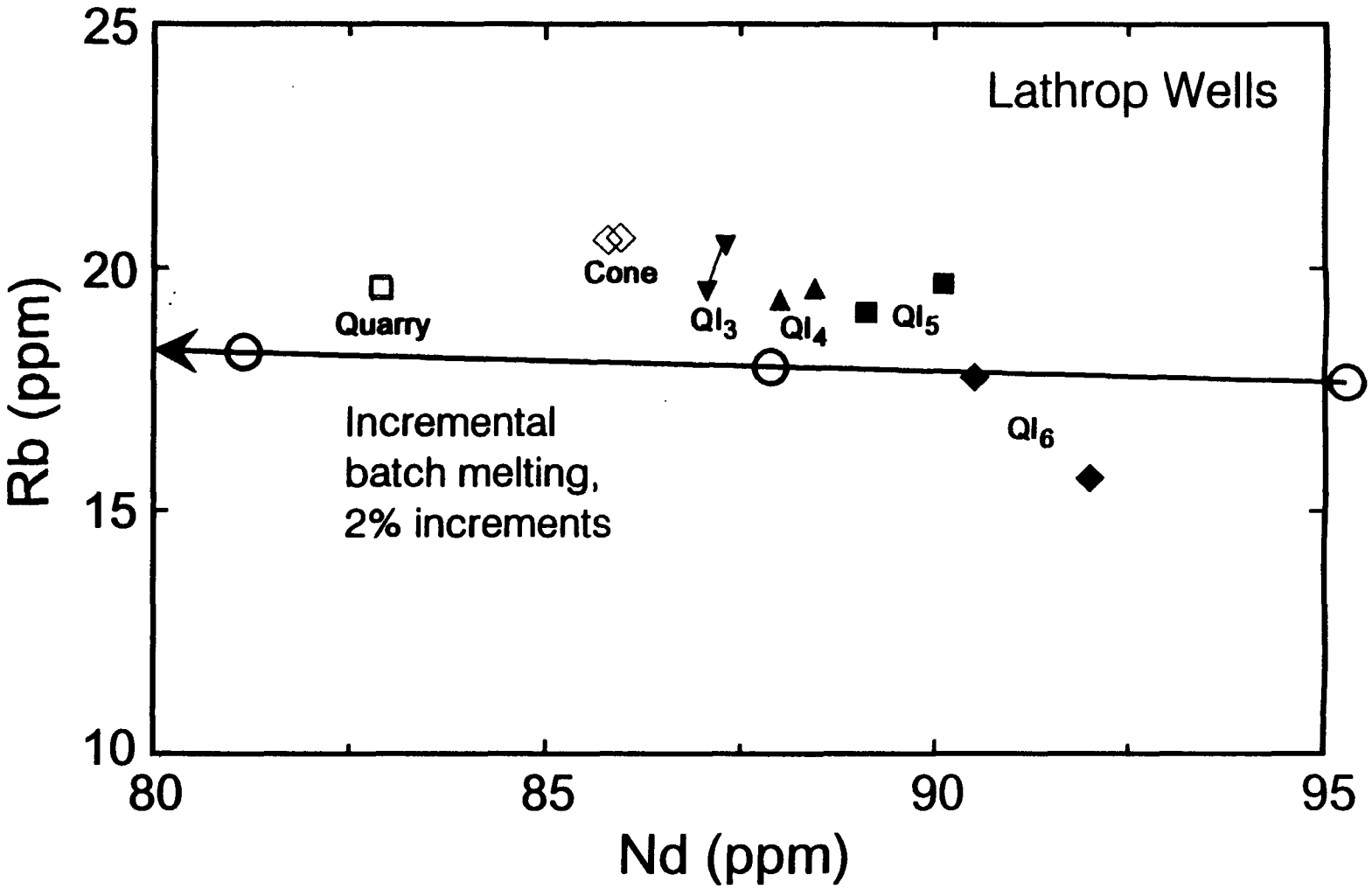
Histogram Showing Mg Numbers (All Major Lava Flows)

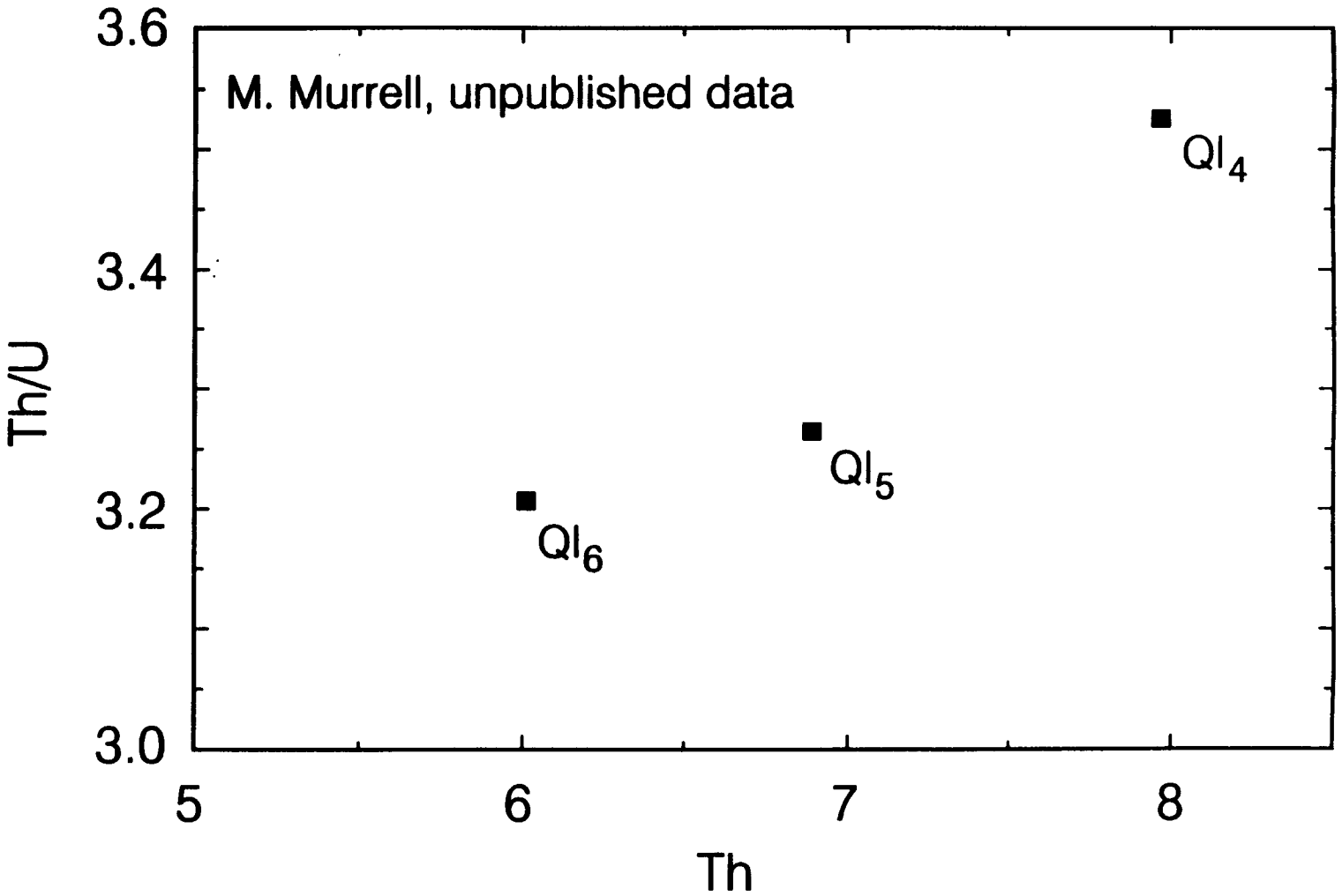


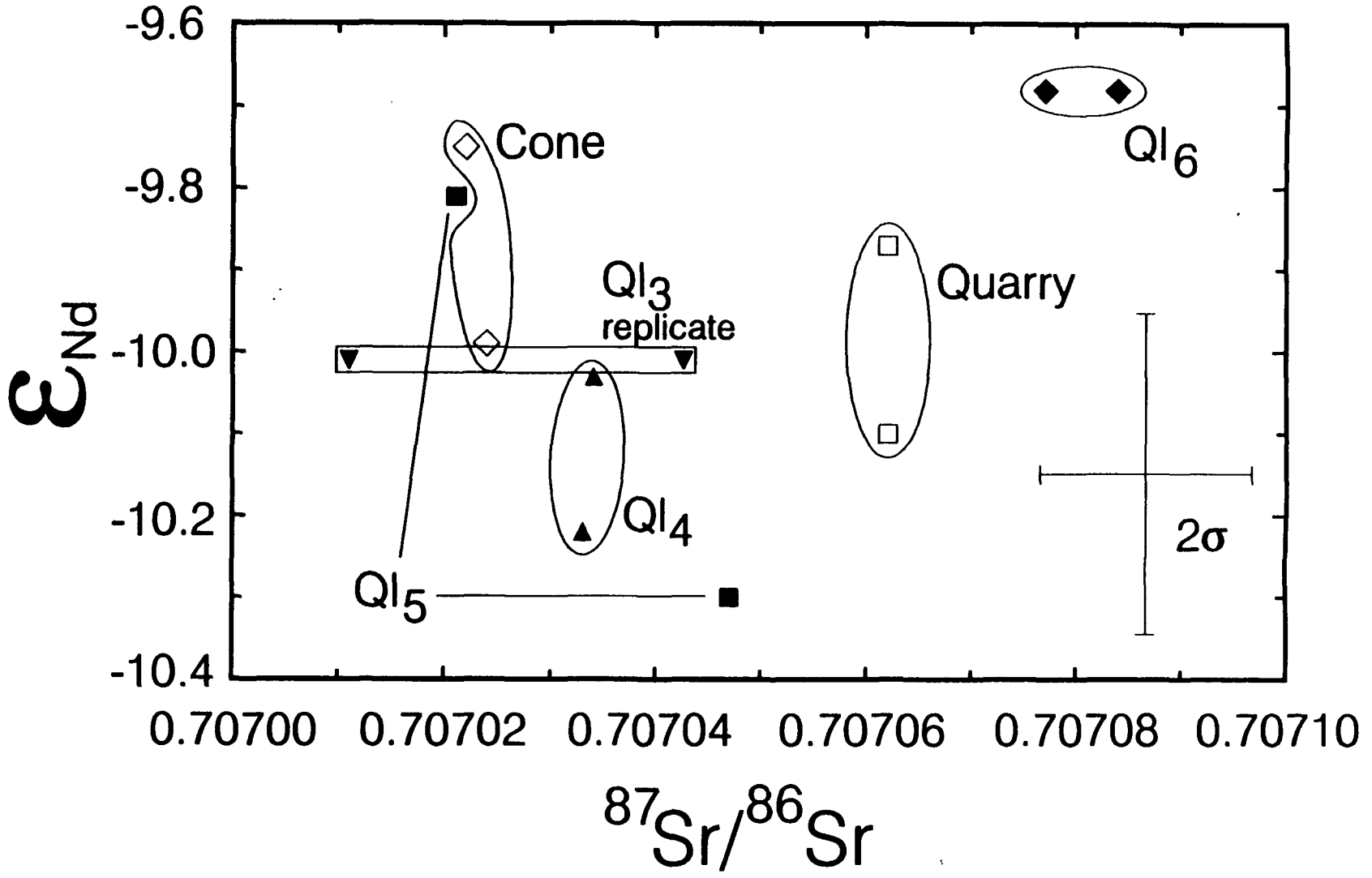

8.2
8.0
7.8
7.6
7.4
7.2
La / Sm
88
90
92
94
96
98
La
QUARRY
Cpx
Ol
Pl
3% fractionation
Ql4
CONE
Ql3
Qs5
Ql5?
Qs4
Ql6?
Ql5
Ql6
2σ


20.8
20.4
20.0
19.6
19.2
18.8
18.4
18.0
Sc
1200
1250
1300
1350
1400
1450
1500
1550
Sr
Ql4
3% fractionation
Pl
Ol
CONE
QUARRY
Cpx
Qs5
Ql4
Ql3
Qs4
Ql5?
Ql5
Ql6
Ql6?
2σ

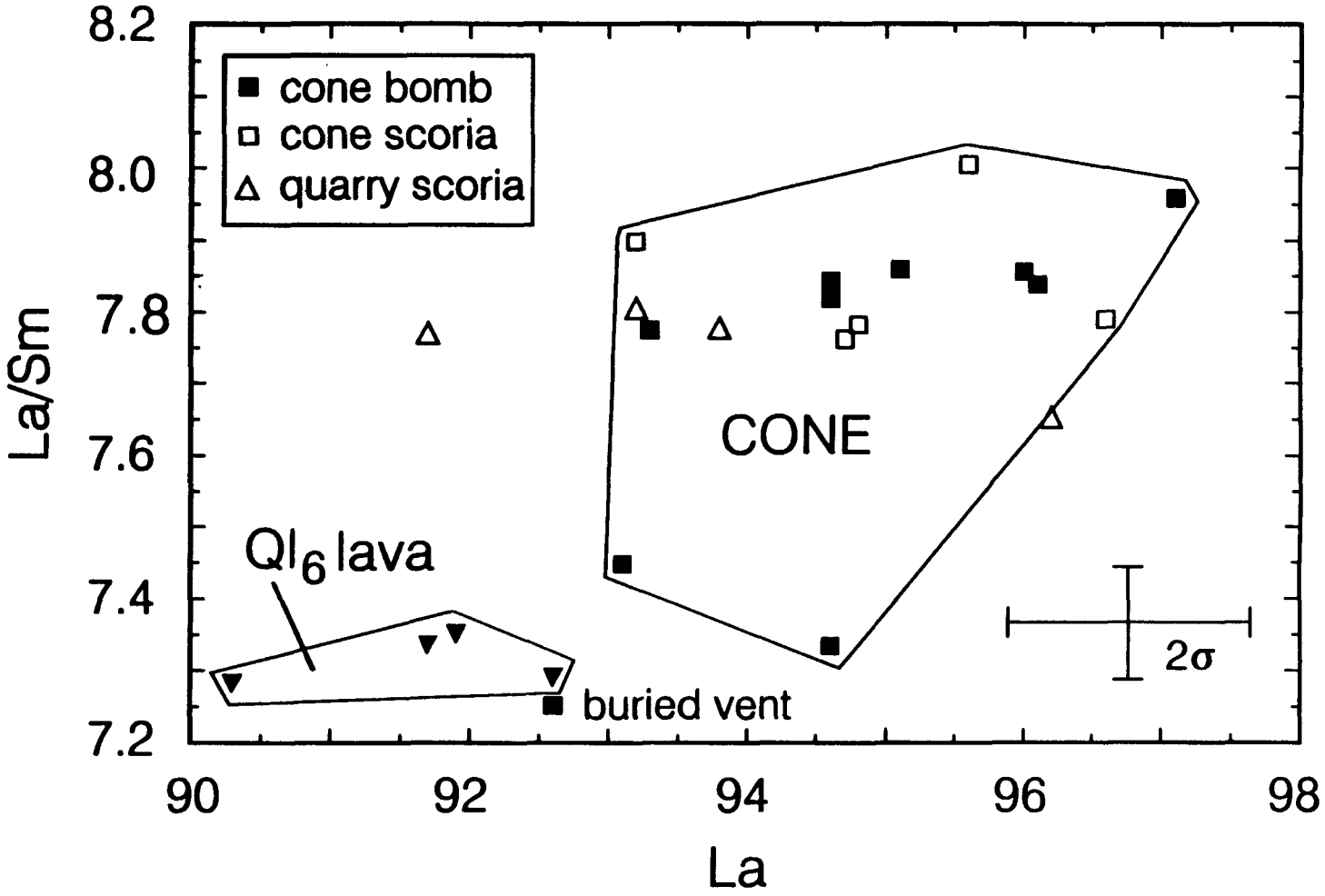

Lathrop Wells
cpx
amph
AFC
ol
plag
5% fractionation
phlog
Quarry
(1.52)
Cone
QI3
QI4
(1.75)
QI5
(1.85)
QI6
(1.77)
Rb (ppm)
Nd (ppm)
25
20
15
10
80
85
90
95

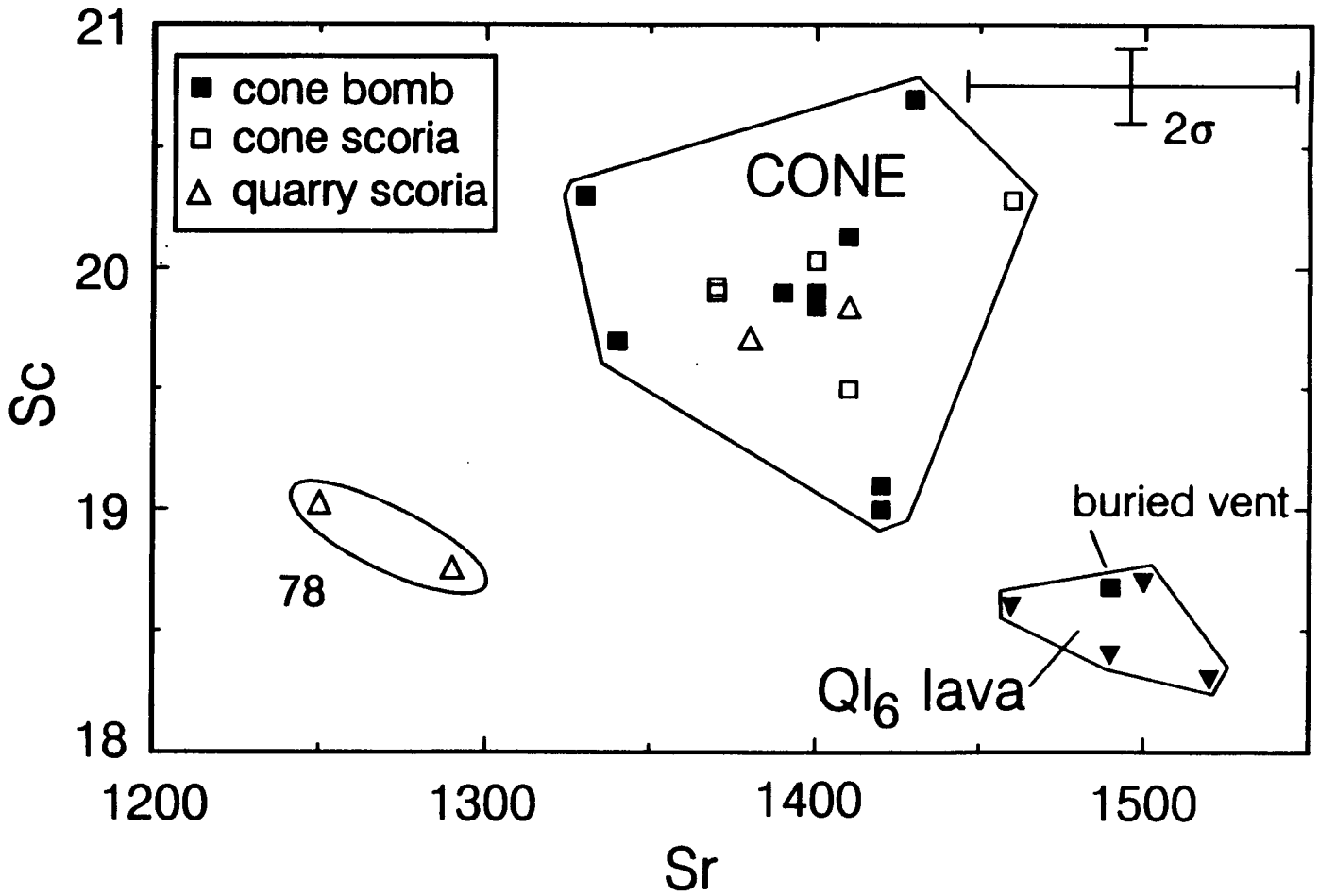

Lathrop Wells
Rb (ppm)
Nd (ppm)
25
20
15
10
80
85
90
95
Quarry
Cone
Ql3
Ql4
Ql5
Ql6
Incremental
batch melting,
2% increments


M. Murrell, unpublished data
QI4
QI5
QI6
3.6
3.4
3.2
3.0
Th/U
5
6
7
8
Th


-9.6
-9.8
-10.0
-10.2
-10.4
ε_{Nd}
Cone
Ql_6
Ql_3
replicate
Quarry
Ql_4
Ql_5
2σ
0.70700
0.70702
0.70704
0.70706
0.70708
0.70710
$^{87}Sr/^{86}Sr$

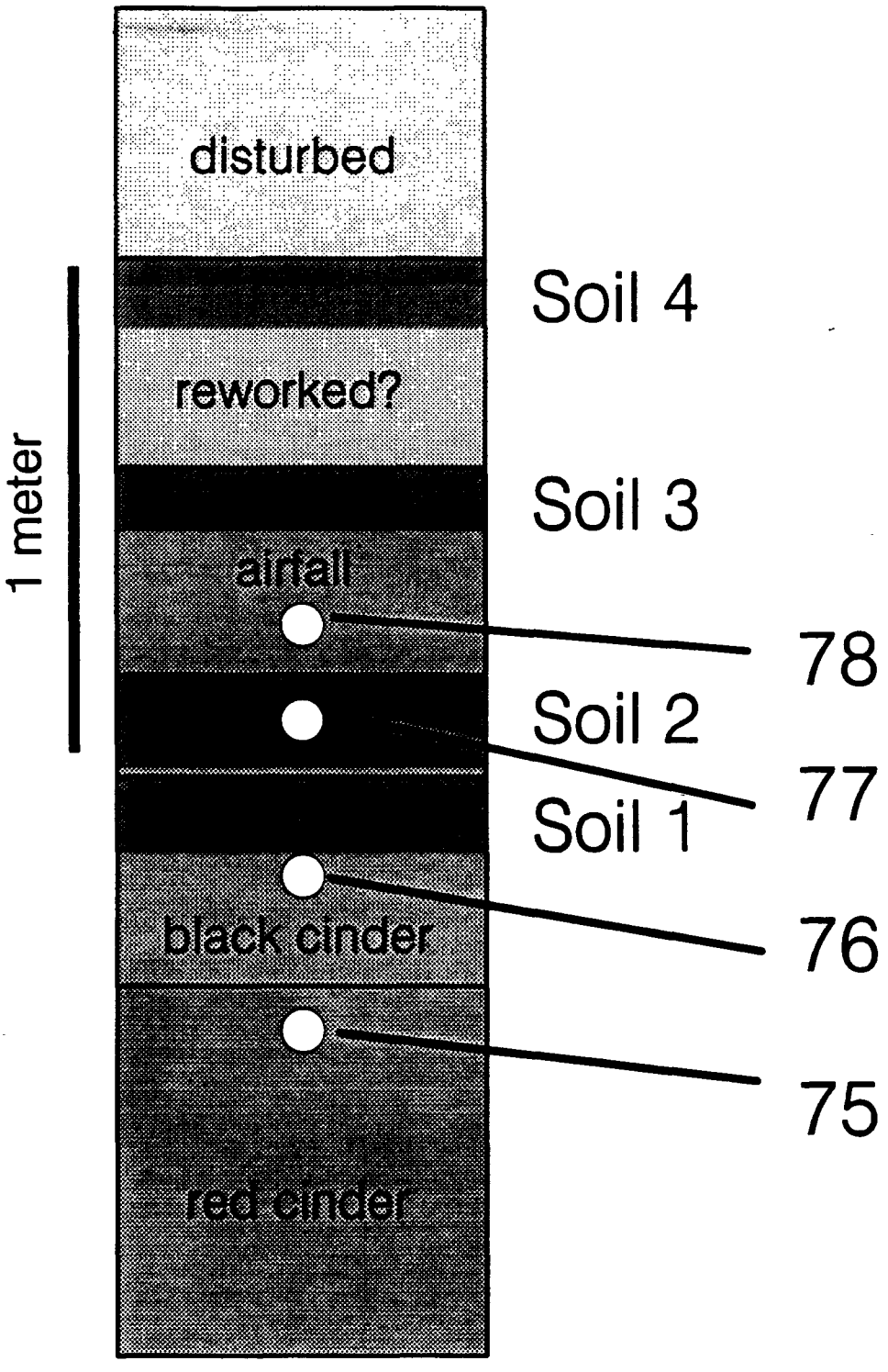
Photograph of Lathrop Wells quarry, showing buried vent for Ql_6 lava

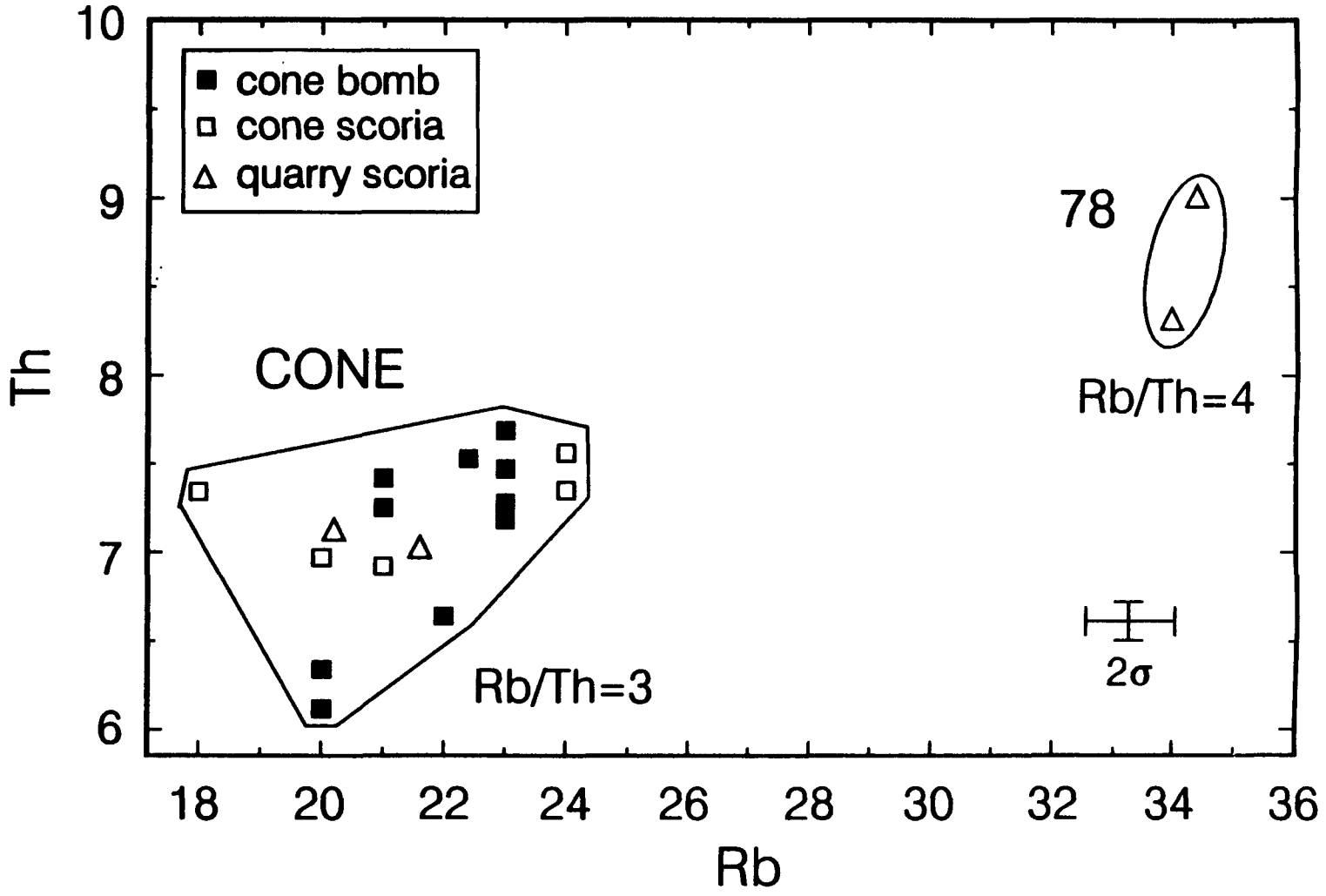

8.2
8.0
7.8
7.6
7.4
7.2
La/Sm
90
92
94
96
98
La
cone bomb
cone scoria
quarry scoria
CONE
Ql6 lava
buried vent
2σ


cone bomb
cone scoria
quarry scoria
2σ
CONE
buried vent
78
Ql6 lava
21
20
19
18
Sc
1200
1300
1400
1500
Sr

Photomicrograph of bomb from QI_6 vent Lathrop Wells/Volcanic Center

Quarry Exposure
Wells et al., 1990




cone bomb
cone scoria
quarry scoria
CONE
Rb/Th=3
78
Rb/Th=4
2σ
Th
Rb
10
9
8
7
6
18
20
22
24
26
28
30
32
34
36

Photomicrographs comparing morphology of cone scoria and scoria from quarry units

Multiple Magma Batches at Lathrop Wells

1. Are multiple magma batches in short period of time reasonable for a region of low magma flux?

2. It is unlikely that multiple magma batches can ascend at same time and place without mixing or homogenization (cf. Kilauea, Saudi Arabia)

3. Multiple, chemically discrete magma batches are most consistent with a long-lived, polycyclic volcano

Conclusions

1. Eruptive units at both Black Cone and Lathrop Wells represent multiple, discrete magma batches
   - Turrin et al. (1992) state that chemical variations at Lathrop Wells are consistent with monogenetic volcanism

2. Soil-bounded scoria units at Lathrop Wells represent discrete magma batches erupted at least thousands of years apart. These units are <u>not</u> derived from the main cone, either by eruption on mass flow mechanisms

Therefore, the most reasonable model for Lathrop Wells and Black Cone is that they are polcyclic centers formed by discrete eruptions separated by at least <u>thousands</u> of years