Manuscript 1524 revision 1

Appendix

THERMOCALC reactions
Endmember abbreviations from Holland and Powell (1998)

P-T estimates (Table 3)

QL1A

cores

••INCOMPLETE•• independent set of reactions
1) 3mu + 6di = 3cel + py + 2gr
2) 3mu + 3di + 2coe = 3cel + gr + 2ky
3) cz + acm = ep + jd
4) mu + 4fep + di + 8jd = cel + 3gr + 8acm + 2H2O + 4ky

T = 545°C, sd = 107,
P = 33.4 kbars, sd = 6.6, cor = 0.782

rims

Independent set of reactions
1) 3mu + 6di = 3cel + py + 2gr
2) 3mu + 3di + 2coe = 3cel + gr + 2ky
3) cz + 2acm = fep + 2jd
4) ep + acm = fep + jd
5) mu + 8ep + di = cel + 3gr + 4fep + 2H2O + 4ky

T = 533°C, sd = 66,
P = 32.5 kbars, sd = 4.4, cor = 0.666

QL6B
core

Independent set of reactions
1) py + 3hed = alm + 3di
2) 3mu + 6di = py + 2gr + 3cel
3) 2py + 6hed + 3gl = 2alm + 6jd + 3tr
4) 5gr + 33hed + 12tr + 6parg = 11alm + 84di + 6jd + 18H2O

T = 591°C, sd = 93,
P = 32.6 kbars, sd = 2.6, cor = -0.451

rim

Independent set of reactions
1) 5py + 3fact = 5alm + 3tr
2) 3mu + 6di = py + 2gr + 3cel
3) py + 3mu + 6hed = 2gr + 2alm + 3cel
4) 5alm + 6di + 3gl = 5py + 6jd + 3fact
5) 17mu + 8tr + 4parg = 13py + 8gr + 17cel + 4jd + 12H2O

T = 660°C, sd = 74,
P = 27.3 kbars, sd = 2.1, cor = -0.382

QL22A

cores-Grt 1

Independent set of reactions
1) gr + alm + 2coe = 3hed + 2ky
2) py + 3mu + 4coe = 3cel + 4ky
3) py + 3hed = alm + 3di

T = 612°C, sd = 106,
P = 27.9 kbars, sd = 5.6, cor = 0.755

cores-Grt 2

Independent set of reactions
1) gr + alm + 2coe = 3hed + 2ky
2) py + 3mu + 4coe = 3cel + 4ky
3) py + 2gr + 3cel = 6di + 3mu
4) gr + 2acm = andr + 2jd

T = 706°C, sd = 115,
P = 30.3 kbars, sd = 5.8, cor = 0.745

core-Grt 3

••INCOMPLETE•• independent set of reactions
1) 3cel + py + 2gr = 3mu + 6di
2) 3cel + gr + 2ky = 3mu + 3di + 2coe
3) 2jd + fep = 2acm + cz
4) jd + fep = acm + ep

T = 606°C, sd = 60,

P = 31.2 kbars, sd = 3.6, cor = 0.708

rims-Grt 3

••INCOMPLETE•• independent set of reactions
1) 3cel + 4ky = 3mu + py + 4coe
2) 3cel + py + 2gr = 3mu + 6di
3) jd + fep = acm + ep

T = 683°C, sd = 77,
P = 31.6 kbars, sd = 4.1, cor = 0.680

QL32
core-Grt 1

Independent set of reactions
1) 6cz = 4gr + coe + 5ky + 3H2O
2) 3tats + 2coe = 2ta + 3ky + H2O
3) ta + ky = py + 2coe + H2O
4) 3ta + py + 2gr = 6di + 3tats
5) alm + 12cz = fta + 8gr + 11ky + 5H2O
6) cz + fep = 2ep
7) 2jd + fep = 2acm + cz
8) py + 2gr + 3cel = 6di + 3mu

T = 591°C, sd = 28,
P = 32.6 kbars, sd = 2.5, cor = -0.347

rim-Grt 1

Independent set of reactions
1) 6cz = 4gr + q + 5ky + 3H2O
2) 3ta + 4ky = 3tats + py + 4q
3) 3tats = ta + py + 2ky + 2H2O
4) 3di + 2ky = py + gr + 2q
5) 3ta + 2py + 4gr = 6di + 3ts
6) 6hed + 3fact + 16ky = 7alm + 6cz + 13q
7) fact + ky = 2hed + alm + 2q + H2O
8) 6di + 5fta = 3fact + 2ta
9) 2parg + 5ta + 6py + 12cz = 2di + 2jd + 13ts
10) cz + fep = 2ep
11) 13di + 10jd + 5fact + 2parg + 6py + 12ep = 25hed + 12acm + 13ts

T = 671°C, sd = 20,
P = 20.8 kbars, sd = 1.3, cor = 0.137

rim-Grt 2

Independent set of reactions
1) 6cz = 4gr + q + 5ky + 3H2O
2) 3ta + 4ky = 3tats + py + 4q
3) 3tats = ta + py + 2ky + 2H2O
4) 3di + 2ky = py + gr + 2q
5) 3ta + 2py + 4gr = 6di + 3ts
6) 6hed + 3fact + 16ky = 7alm + 6cz + 13q
7) 13fact + 6cz = 38hed + 9alm + 19q + 16H2O
8) 6hed + 3fact + 6fep + 16ky = 7alm + 12ep + 13q
9) 6hed + 6acm + 3fact + 16ky = 6jd + 7alm + 6ep + 13q
10) 13di + 5fact + 2parg + 6py + 12cz = 25hed + 2jd + 13ts

T = 659°C, sd = 20,
P = 20.1 kbars, sd = 1.4, cor = 0.166

Calculated reactions plotted in Fig. 12

activites (calculated from QL32 rim compositions using
the a-X program of Holland and Powell 1998):

di   0.41
py   0.141
gr   0.0179
ta   0.75
tr   0.097
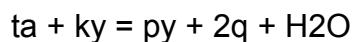
ta + ky = py + 2q + H2O
P   5   15   20.4   25   28.2
T   682   682   672   661   654
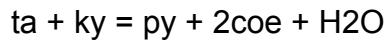
ta + ky = py + 2coe + H2O
P   28.2   31.1   35   45   50
T   654   634   609   546   516

2ta + gr = 3di + py + 2coe + 2H2O
P   31.1   35   45   50
T   634   622   591   577

gr + py + 2coe = 3di + 2ky
P   28.4   31.1
T   694   634

ta + gr = 3di + ky + H2O
```
P       5       15      19.3    23.1    25      31.1
T       575     607     614     621     624     634
```

gr + py + 2q = 3di + 2ky
```
P       5       15      19.3    25      28.4
T       944     840     791     729     694
```

2di + ta = tr
```
T       400     600     800     1000
P       25.3    26.7    28.1    29.6
```

Ab = Jd + Qtz calculated from symplectite of sample QL1A (Holland 1980):

no Fe3 recalc
```
T       400     500     600     700     800     950
P   9.374       10.269      11.164      12.059      12.954      14.297
```

Fe3 recalc
```
T       400     500     600     700     800     950
P       8.443 9.081 9.719 10.357        10.996      11.953
```

Calculated reactions plotted in Fig. 13a
12ep = 8gr + 4alm + 3O2 + 6H2O

QL1A:
```
            gr      alm     ep
activity    0.0193  0.0820  0.470
```

```
log fO2         -15     -14.5  -14   -13.5 -13     -12.5 -12    -11.5 -11    -10.5 -10
T               512     526    539   553   568     583   598    614   631    648   666
```

QL22A:
```
            gr      alm     ep
activity    0.0227  0.0410  0.410
```

```
log fO2         -15     -14.5  -14   -13.5 -13     -12.5 -12    -11.5 -11    -10.5 -10
T       513     526    540    554   568   583     599   615    632   649    667
```

QL32:
```
            gr      alm     ep
activity    0.0179  0.040   0.48
```

```
log fO2 -14.5           -14     -13.5 -13     -12.5 -12     -11.5 -11     -10.5 -10
```

T   511   524   538   552   567   582   597   613   630   647