

Chief Geometry A UDEC model

set gravity= 0.0 -9.81

config

round 5E-2

edge 0.1

block -10,-10 -10,40 10,40 10,-10

crack -0.87,-10 0,0 join

crack 0,0 1,-0.09 join

crack 1,-0.09 4.49,40 join

;jset angle 85 spacing 1 origin 0,0 id 1

crack 0,0 3.503,40 id 1

call remove_area.dat

delete range inside table 1

jregion id 1 0.0,0.0 1,-0.09 4.49,40 3.49,40

jset angle 355 spacing 2.5 origin 0,0 id 2 range jregion 1

gen edge 1.0 range atblock (-5,20)

gen edge 0.25 range jregion 1

group zone 'granite' range -10.8302,7.181 -10.9603,40.6311

zone model elastic density 2.75E3 bulk 2.49971E10 shear 1.15387E10 range group 'granite'

group zone 'granite' range -17.5313,22.272 -18.9744,235.6167

zone model elastic density 2.75E3 bulk 2.49971E10 shear 1.15387E10 range group 'granite'

;vert joints have 25% RB,

group joint 'vert' range id 1

joint model area jks 2e10 jkn 2e11 jfriction 38 jcohesion 3.14e5 jtension 1.38e5 range group 'vert'

;horz joints have 50% RB

group joint 'horizontal' range id 2

joint model area jks 2e10 jkn 2e11 jfriction 38 jcohesion 2.8e6 jtension 1.24e6 range group 'horizontal'

; new contact default

set jcondf joint model area jks=2e10 jkn=2e11 jfriction=30 jcohesion=0 jtension=0

insitu stress -1.35e6 0 -1.35e6 ygrad 2.7e4 0 2.7e4

;boundary stress 0 0 -5.13e6 range -10.2806,4.1597 39.9078,40.2235

```
boundary yvelocity 0 range -10.4607,-0.4206 -10.6053,-9.7152  
boundary yvelocity 0 range -10.3442,11.1434 39.581,40.5514  
boundary xvelocity 0 range -10.8002,-9.5387 -11.1373,40.6459
```

```
;delete range atblock (3.5962,39.9335)
```

```
history xdisplace 0.49545813,-0.049194932 ;id1  
history xdisplace 0.9751992,4.9281187 ;id2  
history xdisplace 1.482381,9.87253 ;id3  
history ydisplace 0.7409704,-0.06522083 ;id4  
history ydisplace 0.95483875,4.9250417 ;id5  
history ydisplace 1.453866,9.858272 ;id6
```

```
solve
```

```
call time_degrade.dat
```

```
call run_steps.dat
```

Chief – Geometry B UDEC model

set gravity= 0.0 -9.81

config
round 5E-2
edge 0.1
block -10,-30 -10,20 10,20 10,-30

crack 2.75,20 2.31,15.02 join
crack 2.31,15.02 3.31,14.93 join
crack 3.31,14.93 -0.61 -30 join

crack 2.31,15.02 -1.608,-30 id 1

call remove_area.dat

delete range inside table 1
save 'geometry.sav'

jregion id 1 2.31,15.02 3.31,14.93 -0.61,-30 -1.608,-30
jset angle 355 spacing 2.5 origin 0,0 id 2 range jregion 1
jset angle 300 spacing 2.5 origin 0,0 id 2 range jregion 1
save 'jset.sav'

gen edge 1.0 range atblock (-5,0)
gen edge 0.25 range jregion 1

group zone 'granite' range -10.8302,7.181 -30.9603,40.6311
zone model elastic density 2.75E3 bulk 2.49971E10 shear 1.15387E10 range group 'granite'
save 'zones.sav'

group joint 'horizontal'
joint model area jks 2e10 jkn 2e11 jfriction 38 jcohesion 1.99e6 jtension 8.7e5 range group
'horizontal'

group joint 'vert' range id 1
joint model area jks 2e10 jkn 2e11 jfriction 38 jcohesion 2.72e5 jtension 1.2e5 range group 'vert'

; new contact default
set jcondf joint model area jks=2e10 jkn=2e11 jfriction=30 jcohesion=0 jtension=0
save 'jprops.sav'

insitu stress -5.4e6 0 -5.4e6 ygrad 2.7e4 0 2.7e4

boundary yvelocity 0 range -10.4607,-0.4206 -30.6053,-29.7152
boundary yvelocity 0 range -10.3442,3 19.581,20.5514
boundary xvelocity 0 range -10.8002,-9.5387 -31.1373,20.6459

history xdisplace 2.8099737,14.974352 ;id1

```
history xdisplace 2.3768287,9.848797 ;id2
history xdisplace 1.9333682,4.8160553 ;id3
history ydisplace 2.8305988,14.964034 ;id4
history ydisplace 2.5108955,9.838481 ;id5
history ydisplace 1.9849328,4.7954307 ;id6
save 'bounds.sav'
```

```
solve cycle 250000
save 'solve.sav'
```

```
call time_degrade.dat
```

```
step 1000
save 'call fish.sav'
```

```
step 500000
```

Diavik model v101

;Diavik v101

set gravity=0.0 -9.81

config

round 0.25

edge 0.5

block 510,8.9E3 510,9.409E3 1.028E3,9.409E3 1.028E3,8.9E3

;Pit outline and kimberlite outline

call pit_outline.dat

call kimberlite.dat

;Diabase outline

call diabase.dat

;9160 plane

crack (675.6101,9.163E3) (672.0442,9.12E3) id 3

crack (672.0442,9.12E3) (626.876,9.009E3) id 3

jdelete

jregion id 1 675.67206,9162.221 672.40344,9120.998 643.1424,9120.998 654.7757,9161.985

jregion id 2 622.16144,9033.913 646.5528,9121.645 672.6831,9121.409 628.91595,9013.77

jset angle 79 spacing 1.5 origin 0,0 range jregion 1 id 4

jset angle 79 spacing 1.5 origin 0,0 range jregion 2 id 4

jdelete

;jset angle 59 spacing 5 origin 0,0 range jregion 1 id 4

;jset angle 59 spacing 5 origin 0,0 range jregion 2 id 4

;jdelete

jset angle 0 spacing 5 origin 0,5 range jregion 1 id 4

jset angle 0 spacing 5 origin 0,5 range jregion 2 id 4

jdelete

delete range atblock (610.4446,9.238E3)

crack (563,9.1E3) (644,9.1E3) join

crack (575,9.05E3) (629,9.05E3) join

crack (561.9576,9.13E3) (648.4639,9.13E3) join

crack (572.6685,9.075E3) (634.007,9.075E3) join

jdelete

crack (634.4438,9.073E3) (637.7224,9.089E3) id 4
crack (637.315,9.08E3) (633.5305,9.08E3) id 4
crack (638.2946,9.085E3) (634.688,9.085E3) id 4
crack (629.3607,9.055E3) (628.5314,9.055E3) id 4
crack (644.6647,9.11E3) (643.9349,9.11E3) id 4
crack (643.722,9.105E3) (642.9617,9.105E3) id 4
crack (653.3448,9.155E3) (651.5049,9.155E3) id 4
crack (652.2075,9.15E3) (650.1,9.15E3) id 4
jdelete

gen edge 10.0 range atblock (584.1254,9.149E3)
gen edge 10.0 range atblock (590.3967,9.092E3)
gen edge 10.0 range atblock (598.5977,9.022E3)
gen edge 20.0 range atblock (569.6531,8.97E3)
gen edge 30.0 range atblock (910.7169,9.087E3)
gen edge 1.5 range 619.8169,677.7676 9.009E3,9.165E3
gen edge 10.0 range atblock (599.8234,9.121E3)
gen edge 10.0 range atblock (593.072,9.059E3)

call kimberlite_table.dat

group zone 'granite'
zone model elastic density 2.65E3 bulk 4.667E10 shear 2.1538E10 range group 'granite'

group zone 'kimberlite' range atblock (604.4164,9.088E3) (604.5,9.146E3) (603.4749,9.062E3)
(605.3005,9.115E3) (601.1085,9.014E3)
zone model mohr density 2.5E3 bulk 2.54386E9 shear 1.10687E9 friction 44 cohesion 6.79E5
tension 6.9E4 range group 'kimberlite'

group joint '9160_jset'
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17E5 jtension 1.57E4 range group
'9160_jset'

group joint 'diabase' range id 2
joint model area jks 2E10 jkn 2E11 jfriction 43 jcohesion 1.5E5 jtension 0 jdilation 0 range group
'diabase'

group joint 'contact_wall' range id 1
joint model area jks 1E10 jkn 1E11 jfriction 22 jcohesion 5E4 jtension 0 jdilation 0 range group
'contact_wall'

; new contact default

set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

boundary xvelocity 0 range 495.742,511.6615 8.891E3,9.168E3
boundary xvelocity 0 range 1.021E3,1.064E3 8.859E3,9.422E3
boundary xvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3
boundary yvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3

insitu stress -1.126e8,0.0,0.0 xgrad 0.0,0.0,0.0 ygrad 11960,0.0,0.0

insitu szz -2.645e8 zgrad 0.0,28080

history ydisplace 650.5006,9145.3 ;id1
history ydisplace 661.1756,9145.056 ;id2
history ydisplace 643.68536,9105.338 ;id3
history ydisplace 656.78265,9105.117 ;id4

history xdisplace 650.7063,9145.57 ;id5
history xdisplace 661.358,9145.015 ;id6
history xdisplace 643.78564,9105.564 ;id7
history xdisplace 656.7477,9105.105 ;id8

solve

call time_degrade_100.dat

set fishcall 0 remove FC

delete range atblock (606.2578,9.149E3)

solve

set fishcall 0 FC

step 100000

set fishcall 0 remove FC

delete range atblock (606.3983,9.12E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (587.9458,9.095E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (604.6303,9.066E3)

solve

set fishcall 0 FC

step 100000

delete range atblock (640.8859,9.095E3)

call run_steps.dat

Diavik model v201

Diavik v201

set gravity=0.0 -9.81

config

round 0.25

edge 0.5

block 510,8.9E3 510,9.409E3 1.028E3,9.409E3 1.028E3,8.9E3

;Pit outline and kimberlite outline

call pit_outline.dat

call kimberlite.dat

;Diabase outline

call diabase.dat

;9160 plane

crack (675.6101,9.163E3) (672.0442,9.12E3) id 3

crack (672.0442,9.12E3) (626.876,9.009E3) id 3

jdelete

jregion id 2 623.5424,9028.779 647.0316,9122.823 672.6831,9121.409 628.91595,9013.77

jregion id 1 675.67206,9162.221 672.40344,9120.998 646.2124,9121.791 654.7757,9161.985

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 1 id 4

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 2 id 4

jdelete

delete range atblock (610.4446,9.238E3)

crack (563,9.1E3) (644,9.1E3) join

crack (575,9.05E3) (629,9.05E3) join

crack (561.9576,9.13E3) (648.4639,9.13E3) join

crack (572.6685,9.075E3) (634.007,9.075E3) join

jdelete

call voronoi.dat

vor id 5 edge 0.95 round 0.04 range inside table 2

jdelete

gen edge 10.0 range atblock (590.3967,9.092E3)

gen edge 10.0 range atblock (598.5977,9.022E3)

gen edge 10.0 range atblock (599.8234,9.121E3)

gen edge 10.0 range atblock (593.072,9.059E3)
gen edge 10.0 range atblock (617.5429,9.141E3)
gen edge 20.0 range atblock (569.6531,8.97E3)
gen edge 30.0 range atblock (910.7169,9.087E3)
gen edge 1.5 range atblock (670.9155,9.121E3)
gen edge 1.5 range atblock (668.6797,9.122E3)
gen edge 1.5 range atblock (665.1863,9.123E3)
gen edge 1.5 range atblock (662.6711,9.124E3)
gen edge 1.5 range atblock (659.5969,9.124E3)
gen edge 1.5 range atblock (650.7935,9.069E3)
gen edge 1.5 range atblock (649.3961,9.069E3)
gen edge 1.0 range inside table 2

call kimberlite_table.dat

group zone 'granite'
zone model elastic density 2.65E3 bulk 4.667E10 shear 2.1538E10 range group 'granite'

group zone 'kimberlite' range atblock (604.4164,9.088E3) (604.5,9.146E3) (603.4749,9.062E3)
(605.3005,9.115E3) (601.1085,9.014E3)
zone model mohr density 2.5E3 bulk 2.54386E9 shear 1.10687E9 friction 44 cohesion 6.79E5
tension 6.9E4 range group 'kimberlite'

; new contact default

set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

group joint 'all'
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17e5 jtension 1.57e4

group joint 'voronoi' range id 5
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 1.08e6 jtension 4.4e5 range group
'voronoi'

group joint '9160_jset' range id 3
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17E5 jtension 8.7E4 range group
'9160_jset'

group joint 'diabase' range id 2
joint model area jks 2E10 jkn 2E11 jfriction 43 jcohesion 1.5E5 jtension 0 jdilation 0 range group
'diabase'

group joint 'contact_wall' range id 1
joint model area jks 1E10 jkn 1E11 jfriction 22 jcohesion 5E4 jtension 0 jdilation 0 range group
'contact_wall'

boundary xvelocity 0 range 495.742,511.6615 8.891E3,9.168E3
boundary xvelocity 0 range 1.021E3,1.064E3 8.859E3,9.422E3
boundary xvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3
boundary yvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3

insitu stress -1.126e8,0.0,0.0 xgrad 0.0,0.0,0.0 ygrad 11960,0.0,0.0
insitu szz -2.645e8 zgrad 0.0,28080

history ydisplace 650.5006,9145.3 ;id1
history ydisplace 661.1756,9145.056 ;id2
history ydisplace 643.68536,9105.338 ;id3
history ydisplace 656.78265,9105.117 ;id4

history xdisplace 650.7063,9145.57 ;id5
history xdisplace 661.358,9145.015 ;id6
history xdisplace 643.78564,9105.564 ;id7
history xdisplace 656.7477,9105.105 ;id8

solve

call time_degrade.dat

set fishcall 0 remove FC

delete range atblock (606.2578,9.149E3)

solve

set fishcall 0 FC

step 100000

set fishcall 0 remove FC

delete range atblock (606.3983,9.12E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (587.9458,9.095E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (604.6303,9.066E3)

solve

set fishcall 0 FC

call run_steps.dat

Diavik model v202

;Diavik v202

set gravity=0.0 -9.81

config

round 0.25

edge 0.5

block 510,8.9E3 510,9.409E3 1.028E3,9.409E3 1.028E3,8.9E3

;Pit outline and kimberlite outline

call pit_outline.dat

call kimberlite.dat

;Diabase outline

call diabase.dat

;9160 plane

crack (675.6101,9.163E3) (672.0442,9.12E3) id 3

crack (672.0442,9.12E3) (626.876,9.009E3) id 3

jdelete

jregion id 2 623.5424,9028.779 647.0316,9122.823 672.6831,9121.409 628.91595,9013.77

jregion id 1 675.67206,9162.221 672.40344,9120.998 646.2124,9121.791 654.7757,9161.985

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 1 id 4

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 2 id 4

jdelete

delete range atblock (610.4446,9.238E3)

crack (563,9.1E3) (644,9.1E3) join

crack (575,9.05E3) (629,9.05E3) join

crack (561.9576,9.13E3) (648.4639,9.13E3) join

crack (572.6685,9.075E3) (634.007,9.075E3) join

jdelete

call voronoi.dat

vor id 5 edge 0.95 round 0.04 range inside table 2

jdelete

gen edge 10.0 range atblock (590.3967,9.092E3)

gen edge 10.0 range atblock (598.5977,9.022E3)

gen edge 10.0 range atblock (599.8234,9.121E3)

gen edge 10.0 range atblock (593.072,9.059E3)
gen edge 10.0 range atblock (617.5429,9.141E3)
gen edge 20.0 range atblock (569.6531,8.97E3)
gen edge 30.0 range atblock (910.7169,9.087E3)
gen edge 1.5 range atblock (670.9155,9.121E3)
gen edge 1.5 range atblock (668.6797,9.122E3)
gen edge 1.5 range atblock (665.1863,9.123E3)
gen edge 1.5 range atblock (662.6711,9.124E3)
gen edge 1.5 range atblock (659.5969,9.124E3)
gen edge 1.5 range atblock (650.7935,9.069E3)
gen edge 1.5 range atblock (649.3961,9.069E3)
gen edge 1.0 range inside table 2

call kimberlite_table.dat

group zone 'granite'
zone model elastic density 2.65E3 bulk 4.667E10 shear 2.1538E10 range group 'granite'

group zone 'kimberlite' range atblock (604.4164,9.088E3) (604.5,9.146E3) (603.4749,9.062E3)
(605.3005,9.115E3) (601.1085,9.014E3)
zone model mohr density 2.5E3 bulk 2.54386E9 shear 1.10687E9 friction 44 cohesion 6.79E5
tension 6.9E4 range group 'kimberlite'

; new contact default
set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

; new contact default
set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

group joint 'all'
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17e5 jtension 1.57e4

group joint 'voronoi-75' range id 5 angle -90,-60.01
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 8.4e5 jtension 3.4e5 range group
'voronoi-75'

group joint 'voronoi45' range id 5 angle -60,-30.01
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 9.7e5 jtension 3.9e5 range group
'voronoi-45'

group joint 'voronoi45' range id 5 angle 30,59.9
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 9.7e5 jtension 3.9e5 range group
'voronoi-45'

group joint 'voronoi15' range id 5 angle -30,30
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 1.19e6 jtension 4.8e5 range group
'voronoi-15'

group joint 'voronoi75' range id 5 angle 60.0,89.9
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 6.9e5 jtension 2.8e5 range group
'voronoi75'

group joint '9160_jset' range id 3
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17E5 jtension 8.7E4 range group
'9160_jset'

group joint 'diabase' range id 2
joint model area jks 2E10 jkn 2E11 jfriction 43 jcohesion 1.5E5 jtension 0 jdilation 0 range group
'diabase'

group joint 'contact_wall' range id 1
joint model area jks 1E10 jkn 1E11 jfriction 22 jcohesion 5E4 jtension 0 jdilation 0 range group
'contact_wall'

boundary xvelocity 0 range 495.742,511.6615 8.891E3,9.168E3
boundary xvelocity 0 range 1.021E3,1.064E3 8.859E3,9.422E3
boundary xvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3
boundary yvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3

insitu stress -1.126e8,0.0,0.0 xgrad 0.0,0.0,0.0 ygrad 11960,0.0,0.0
insitu szz -2.645e8 zgrad 0.0,28080

history ydisplace 650.5006,9145.3 ;id1
history ydisplace 661.1756,9145.056 ;id2
history ydisplace 643.68536,9105.338 ;id3
history ydisplace 656.78265,9105.117 ;id4

history xdisplace 650.7063,9145.57 ;id5
history xdisplace 661.358,9145.015 ;id6
history xdisplace 643.78564,9105.564 ;id7
history xdisplace 656.7477,9105.105 ;id8

solve

call time_degrade.dat

set fishcall 0 remove FC

delete range atblock (606.2578,9.149E3)

solve

set fishcall 0 FC

step 100000

set fishcall 0 remove FC

delete range atblock (606.3983,9.12E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (587.9458,9.095E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (604.6303,9.066E3)

solve

set fishcall 0 FC

call run_steps.dat

Diavik model v203

;Diavik v203

set gravity=0.0 -9.81

config

round 0.25

edge 0.5

block 510,8.9E3 510,9.409E3 1.028E3,9.409E3 1.028E3,8.9E3

;Pit outline and kimberlite outline

call pit_outline.dat

call kimberlite.dat

;Diabase outline

call diabase.dat

;9160 plane

crack (675.6101,9.163E3) (672.0442,9.12E3) id 3

crack (672.0442,9.12E3) (626.876,9.009E3) id 3

jdelete

jregion id 2 623.5424,9028.779 647.0316,9122.823 672.6831,9121.409 628.91595,9013.77

jregion id 1 675.67206,9162.221 672.40344,9120.998 646.2124,9121.791 654.7757,9161.985

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 1 id 4

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 2 id 4

jdelete

call rockfall1.dat

jdelete

delete range atblock (610.4446,9.238E3)

crack (563,9.1E3) (644,9.1E3) join

crack (575,9.05E3) (629,9.05E3) join

crack (561.9576,9.13E3) (648.4639,9.13E3) join

crack (572.6685,9.075E3) (634.007,9.075E3) join

jdelete

call voronoi.dat

vor id 5 edge 0.95 round 0.04 range inside table 2

jdelete

gen edge 10.0 range atblock (590.3967,9.092E3)
gen edge 10.0 range atblock (598.5977,9.022E3)
gen edge 10.0 range atblock (599.8234,9.121E3)
gen edge 10.0 range atblock (593.072,9.059E3)
gen edge 10.0 range atblock (617.5429,9.141E3)
gen edge 20.0 range atblock (569.6531,8.97E3)
gen edge 30.0 range atblock (910.7169,9.087E3)
gen edge 1.5 range atblock (670.9155,9.121E3)
gen edge 1.5 range atblock (668.6797,9.122E3)
gen edge 1.5 range atblock (665.1863,9.123E3)
gen edge 1.5 range atblock (662.6711,9.124E3)
gen edge 1.5 range atblock (659.5969,9.124E3)
gen edge 1.5 range atblock (650.7935,9.069E3)
gen edge 1.5 range atblock (649.3961,9.069E3)
gen edge 1.0 range inside table 2

call kimberlite_table.dat

group zone 'granite'

zone model elastic density 2.65E3 bulk 4.667E10 shear 2.1538E10 range group 'granite'

group zone 'kimberlite' range atblock (604.4164,9.088E3) (604.5,9.146E3) (603.4749,9.062E3)
(605.3005,9.115E3) (601.1085,9.014E3)

zone model mohr density 2.5E3 bulk 2.54386E9 shear 1.10687E9 friction 44 cohesion 6.79E5
tension 6.9E4 range group 'kimberlite'

; new contact default

set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

; new contact default

set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

group joint 'all'

joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17e5 jtension 1.57e4

group joint 'voronoi-75' range id 5 angle -90,-60.01

joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 8.4e5 jtension 3.4e5 range group
'voronoi-75'

group joint 'voronoi45' range id 5 angle -60,-30.01

joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 9.7e5 jtension 3.9e5 range group
'voronoi-45'

group joint 'voronoi45' range id 5 angle 30,59.9

joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 9.7e5 jtension 3.9e5 range group
'voronoi-45'

group joint 'voronoi15' range id 5 angle -30,30

joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 1.19e6 jtension 4.8e5 range group
'voronoi-15'

group joint 'voronoi75' range id 5 angle 60.0,89.9
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 6.9e5 jtension 2.8e5 range group
'voronoi75'

group joint '9160_jset' range id 3
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17E5 jtension 8.7E4 range group
'9160_jset'

group joint 'diabase' range id 2
joint model area jks 2E10 jkn 2E11 jfriction 43 jcohesion 1.5E5 jtension 0 jdilation 0 range group
'diabase'

group joint 'contact_wall' range id 1
joint model area jks 1E10 jkn 1E11 jfriction 22 jcohesion 5E4 jtension 0 jdilation 0 range group
'contact_wall'

boundary xvelocity 0 range 495.742,511.6615 8.891E3,9.168E3
boundary xvelocity 0 range 1.021E3,1.064E3 8.859E3,9.422E3
boundary xvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3
boundary yvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3

insitu stress -1.126e8,0.0,0.0 xgrad 0.0,0.0,0.0 ygrad 11960,0.0,0.0
insitu szz -2.645e8 zgrad 0.0,28080

history ydisplace 650.5006,9145.3 ;id1
history ydisplace 661.1756,9145.056 ;id2
history ydisplace 643.68536,9105.338 ;id3
history ydisplace 656.78265,9105.117 ;id4

history xdisplace 650.7063,9145.57 ;id5
history xdisplace 661.358,9145.015 ;id6
history xdisplace 643.78564,9105.564 ;id7
history xdisplace 656.7477,9105.105 ;id8

solve

call time_degrade_203.dat

set fishcall 0 remove FC

delete range atblock (606.2578,9.149E3)

solve

set fishcall 0 FC

step 100000

```
set fishcall 0 remove FC
delete range atblock (606.3983,9.12E3)
solve
set fishcall 0 FC
step 500000
set fishcall 0 remove FC
delete range atblock (587.9458,9.095E3)
solve
set fishcall 0 FC
step 500000
set fishcall 0 remove FC
delete range atblock (604.6303,9.066E3)
solve
set fishcall 0 FC
step 100000
call rockfall_tab.dat
delete range inside table 3
set fishcall 0 remove FC
solve
set fishcall 0 FC
step 100000
call run_steps.dat
```

Diavik model v204

;Diavik v204

set gravity=0.0 -9.81

config

round 0.25

edge 0.5

block 510,8.9E3 510,9.409E3 1.028E3,9.409E3 1.028E3,8.9E3

;Pit outline and kimberlite outline

call pit_outline.dat

call kimberlite.dat

;Diabase outline

call diabase.dat

;9160 plane

crack (675.6101,9.163E3) (672.0442,9.12E3) id 3

crack (672.0442,9.12E3) (626.876,9.009E3) id 3

jdelete

jregion id 2 623.5424,9028.779 647.0316,9122.823 672.6831,9121.409 628.91595,9013.77

jregion id 1 675.67206,9162.221 672.40344,9120.998 646.2124,9121.791 654.7757,9161.985

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 1 id 4

jset id 3 angle 79 spacing 3 origin 0,0 range jregion 2 id 4

jdelete

delete range atblock (610.4446,9.238E3)

crack (563,9.1E3) (644,9.1E3) join

crack (575,9.05E3) (629,9.05E3) join

crack (561.9576,9.13E3) (648.4639,9.13E3) join

crack (572.6685,9.075E3) (634.007,9.075E3) join

jdelete

call voronoi.dat

vor id 5 edge 0.95 round 0.04 range inside table 2

jdelete

gen edge 10.0 range atblock (590.3967,9.092E3)

gen edge 10.0 range atblock (598.5977,9.022E3)

gen edge 10.0 range atblock (599.8234,9.121E3)

gen edge 10.0 range atblock (593.072,9.059E3)
gen edge 10.0 range atblock (617.5429,9.141E3)
gen edge 20.0 range atblock (569.6531,8.97E3)
gen edge 30.0 range atblock (910.7169,9.087E3)
gen edge 1.5 range atblock (670.9155,9.121E3)
gen edge 1.5 range atblock (668.6797,9.122E3)
gen edge 1.5 range atblock (665.1863,9.123E3)
gen edge 1.5 range atblock (662.6711,9.124E3)
gen edge 1.5 range atblock (659.5969,9.124E3)
gen edge 1.5 range atblock (650.7935,9.069E3)
gen edge 1.5 range atblock (649.3961,9.069E3)
gen edge 1.0 range inside table 2

call kimberlite_table.dat

group zone 'granite'
zone model elastic density 2.65E3 bulk 4.667E10 shear 2.1538E10 range group 'granite'

group zone 'kimberlite' range atblock (604.4164,9.088E3) (604.5,9.146E3) (603.4749,9.062E3)
(605.3005,9.115E3) (601.1085,9.014E3)
zone model mohr density 2.5E3 bulk 2.54386E9 shear 1.10687E9 friction 44 cohesion 6.79E5
tension 6.9E4 range group 'kimberlite'

; new contact default
set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

; new contact default
set jcondf joint model area jks=2E10 jkn=2E11 jfriction=30 jcohesion=0 jtension=0

group joint 'all'
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17e5 jtension 1.57e4

group joint 'voronoi-75' range id 5 angle -90,-60.01
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 8.4e5 jtension 3.4e5 range group
'voronoi-75'

group joint 'voronoi45' range id 5 angle -60,-30.01
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 9.7e5 jtension 3.9e5 range group
'voronoi-45'

group joint 'voronoi45' range id 5 angle 30,59.9
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 9.7e5 jtension 3.9e5 range group
'voronoi-45'

group joint 'voronoi15' range id 5 angle -30,30
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 1.19e6 jtension 4.8e5 range group
'voronoi-15'

group joint 'voronoi75' range id 5 angle 60.0,89.9
joint model area jks 2E10 jkn 2E11 jfriction 42 jcohesion 6.9e5 jtension 2.8e5 range group
'voronoi75'

group joint '9160_jset' range id 3
joint model area jks 2E10 jkn 2E11 jfriction 30 jcohesion 2.17E5 jtension 8.7E4 range group
'9160_jset'

group joint 'diabase' range id 2
joint model area jks 2E10 jkn 2E11 jfriction 43 jcohesion 1.5E5 jtension 0 jdilation 0 range group
'diabase'

group joint 'contact_wall' range id 1
joint model area jks 1E10 jkn 1E11 jfriction 22 jcohesion 5E4 jtension 0 jdilation 0 range group
'contact_wall'

boundary xvelocity 0 range 495.742,511.6615 8.891E3,9.168E3
boundary xvelocity 0 range 1.021E3,1.064E3 8.859E3,9.422E3
boundary xvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3
boundary yvelocity 0 range 505.39,1.042E3 8.894E3,8.905E3

insitu stress -1.126e8,0.0,0.0 xgrad 0.0,0.0,0.0 ygrad 11960,0.0,0.0
insitu szz -2.645e8 zgrad 0.0,28080

history ydisplace 650.5006,9145.3 ;id1
history ydisplace 661.1756,9145.056 ;id2
history ydisplace 643.68536,9105.338 ;id3
history ydisplace 656.78265,9105.117 ;id4

history xdisplace 650.7063,9145.57 ;id5
history xdisplace 661.358,9145.015 ;id6
history xdisplace 643.78564,9105.564 ;id7
history xdisplace 656.7477,9105.105 ;id8

solve

call time_degrade.dat

set fishcall 0 remove FC

delete range atblock (606.2578,9.149E3)

solve

set fishcall 0 FC

step 100000

set fishcall 0 remove FC

delete range atblock (606.3983,9.12E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (587.9458,9.095E3)

solve

set fishcall 0 FC

step 500000

set fishcall 0 remove FC

delete range atblock (604.6303,9.066E3)

solve

set fishcall 0 FC

step 100000

set fishcall 0 remove FC

delete range atblock (604.6303,9.045E3)

solve

set fishcall 0 FC

step 100000

call run_steps.dat

Time degradation FISH function (time_degrade.dat)

```
; time degrade for chief_a
; parameters must be re-set for each joint type

def FC

WHILESTEPPING
;For all joint groups
;Set initial values for rock bridge parameters
;and subcritical crack growth parameters
cco_orig_j1 = 3.14e5
cco_orig_j2 = 2.8e6 ;initial cohesion of joints
tens_orig_j1 = 1.38e5
tens_orig_j2 = 1.24e6 ;initial tensile strength of joint
spA = 1E-5 ;//Subcritical parameter A - original value 1E-5 m/s
spn = 25 ;Subcritical parameter n - original value 25
Kic = 1.54e6 ;Mode I fracture toughness - = 0.145*tensile str. of rock
Kiic = 3.17e6 ;Mode II fracture toughness - 0.5MPa/m2
wj1 = 20 ;Spacing between rock bridges - increase for more persistent joints
wj2 = 0.5
t = 7200*tdel ;time step
noc = 0
sumco = 0
sumal = 0
;sumtens = 0
t_le = 0
t_nf = 0
t_sf = 0

;Loop over each discontinuity element
ci=contact_head

loop while ci# 0

;Contact length, shear force, normal force
;cohesion and tensile strength are obtained
cle = c_length(ci) ;contact length
csf = c_sforce(ci) ;shear force
cnf = c_nforce(ci) ;normal force
csd = c_sdis(ci) ;shear displacement
cnd = c_ndis(ci) ;normal displacement

cgr = c_group(ci) ;contact group - this causes program to crash

cjl = c_jex(ci)
cco = fmem(cjl+3) ;cohesion
cfa = fmem(cjl+4) ;friction angle
ctens = fmem(cjl+6) ;tensile strength
```

;contact must belong to specific jset

;contact must have non-zero length
if cle # 0

;shear and normal stress calculation
css = csf / cle
cns = cnf / cle

;if displacement is greater than 0.001x length, cohesion set to 0
if csd > 0.05*cle
 cco = 0
 fmem(cj1+3) = 0
endif
;if normal displacement is greater than 0.001 m, tensile strength = 0
if cnd >0.001
 ctens = 0
 fmem(cj1+6) = 0
endif

;Kemeny analysis
;rock bridge length calculation

if cgr = 'vert'
 w = wj1
else
 w = wj2
endif

if cco > 0 ;if equal or lower than 0 it will not be evaluated
 al = ((2 * w * cco)/(Kiic * sqrt(pi)))^2

;stress intensity factor
;likely to be negative if only vertical stress is applied

kii = ((abs(css) - cns * tan(pi*cfa/180)) * 2 * w) / sqrt(pi * al)

;Either ki or Kii must be positive. Here w2e use a bitwise AND
;function which will return true only if both ki and kii are <= 0
if cns<0
 Ki = (cns * 2 * w)/sqrt(pi*al)
 Kichk = 2
else
 Ki = 0

```

    Kichk = 1
endif

if kii > 0
    kiichk = 4
else
    kiichk = 1
endif

if and(Kichk,kiichk) = 0

;calculation of Me
Me = (1/(2*pi))*atan2(Ki,kii)

;calculation of Keff
Keff = sqrt(Kii^2+Ki^2)

;calculation of deltaa
a_var = - spA*(Keff/(Me*Kic+(1-Me)*Kiic))^spn

;new2 al value
al = al + a_var * t

;cohesion calculation and substitution
if al > 0
    cco = (kiic * sqrt ( pi * al )) / (2*w)
    fmem(cjl+3) = cco
else
    fmem(cjl+3) = 0
endif

;tensile strength calculation

if al > 0
    if cgr = 'vert'
        cco_ratio = cco/cco_orig_j1
        tens_t = tens_orig_j1 * cco_ratio
        fmem(cjl+6) = tens_t
    endif
    if cgr = 'horizontal'
        cco_ratio = cco/cco_orig_j2
        tens_t = tens_orig_j2 * cco_ratio
        fmem(cjl+6) = tens_t
    endif
endif

else
    fmem(cjl+6) = 0
endif

```

```
endif  
endif  
endif
```

```
if cgr = 'vert'
```

```
  ;Sum cohesion  
  sumco = sumco + cco
```

```
  ;Sum al  
  sumal = sumal + al
```

```
  ;Total joint length  
  cle = c_length(ci) ;contact length  
  t_le = t_le + cle
```

```
  ;total normal force  
  cnf = fmem (ci + 17)  
  t_nf = t_nf + cnf
```

```
  ;total shear force  
  csf = fmem (ci + 16)  
  t_sf = t_sf + csf
```

```
  ;contact number updated  
  noc = noc + 1
```

```
endif
```

```
  cgr = "  
  ;next contact  
  ci = c_next(ci)
```

```
endloop
```

```
  ;explicit joint length  
  t_le2_exp1 = cle0 + cle1 + cle2 + cle3 + cle4 + cle5 + cle6 + cle7  
  t_le2_exp2 = cle8 + cle8 + cle9 + cle10 + cle11 + cle12 + cle13  
  t_le2_exp = t_le2_exp1 + t_le2_exp2
```

```
  ;average cohesion  
  avco = sumco / noc
```

```
  ;average al  
  aval = sumal / noc
```

```
;average contact length  
avg_le = t_le / noc
```

```
end
```

```
history aval ;id7  
history avco ;id8
```

```
def bp  
command  
print fish  
endcommand  
end  
bp
```

Associated files

Other files used in generating the UDEC models

```
;remove_area.dat
```

```
; exposes chief slope
```

```
table 1
```

```
table 1 -0.87 -10 10 -10 10 40 4.49 40 1 -0.09 0 0
```

```
;diabase.dat
```

```
;defines diabase dyke in Diavik models
```

```
crack 739.5765 8.792E3 739.5765 8.792E3 id 2
```

```
crack 738.1408,8.796E3 739.5765,8.792E3 id 2
```

```
crack 686.844 8979.437 738.1408,8.796E3 id 2
```

```
crack 693.141 8963.713 686.844 8979.437 id 2
```

```
crack 686.844 8979.437 676.905 9004.252 id 2
```

```
crack 676.905 9004.252 652.384 9066.027 id 2
```

```
crack 652.384 9066.027 651.373 9068.295 id 2
```

```
crack 651.373 9068.295 643.364 9092.118 id 2
```

```
crack 643.364 9092.118 643.189 9093.871 id 2
```

```
crack 643.189 9093.871 641.197 9114.204 id 2
```

```
crack 641.197 9114.204 641.008 9114.203 id 2
```

```
crack 641.008 9114.203 640.694 9114.208 id 2
```

```
crack 640.694 9114.208 640.286 9117.578 id 2
```

```
;kimberlite.dat
```

```
;defines bounds of kimberlite pipe at Diavik
```

```
crack 553.898 9158.130 556.882 9149.290 id 1
```

```
crack 556.882 9149.290 558.938 9141.830 id 1
```

```
crack 558.938 9141.830 562.070 9131.550 id 1
```

```
crack 562.07 9131.550 564.087 9120.570 id 1
```

```
crack 564.087 9120.570 562.889 9109.370 id 1
```

```
crack 562.889 9109.370 566.308 9099.410 id 1
```

```
crack 566.308 9099.410 569.108 9089.370 id 1
```

```
crack 569.108 9089.370 572.669 9076.630 id 1
```

```
crack 572.669 9076.630 573.882 9069.370 id 1
```

```
crack 573.882 9069.370 575.876 9059.380 id 1
```

```
crack 575.876 9059.380 575.646 9047.390 id 1
```

```
crack 575.646 9047.39 575.887 9039.370 id 1
```

```
crack 575.887 9039.37 575.641 9030.560 id 1
```

```
crack 575.641 9030.56 572.186 9021.930 id 1
```

```
crack 572.186 9021.93 572.464 9016.590 id 1
```

```
crack 572.464 9016.59 580.772 9007.980 id 1
```

```
crack 580.772 9007.98 586.980 9003.730 id 1
```

```
crack 586.98 9003.73 592.884 8998.370 id 1
```

```
crack 592.884 8998.37 597.282 8994.610 id 1
```

```
crack 597.282 8994.61 601.543 8989.370 id 1
```

```
crack 601.543 8989.37 605.072 8981.190 id 1
```

```
crack 605.072 8981.19 619.298 8978.510 id 1
```

```
crack 619.298 8978.51 627.878 8988.540 id 1
```

```
crack 627.878 8988.54 628.385 8994.330 id 1
```

```

crack 628.385      8994.33      628.735      8999.360      id 1
crack 628.735      8999.36      630.031      9007.110      id 1
crack 630.031      9007.11      629.355      9012.830      id 1
crack 629.355      9012.83      626.850      9022.130      id 1
crack 626.85 9022.13      625.717      9029.110      id 1
crack 625.717      9029.11      626.451      9037.260      id 1
crack 626.451      9037.26      627.547      9043.980      id 1
crack 627.547      9043.98      628.594      9052.840      id 1
crack 628.594      9052.84      629.520      9059.630      id 1
crack 629.52 9059.63      632.075      9067.050      id 1
crack 632.075      9067.05      634.293      9076.170      id 1
crack 634.293      9076.17      634.644      9081.790      id 1
crack 634.644      9081.79      637.804      9089.360      id 1
crack 637.804      9089.36      642.359      9096.940      id 1
crack 642.359      9096.94      643.770      9108.660      id 1
crack 643.77 9108.66      647.309      9121.590      id 1
crack 647.309      9121.59      648.467      9131.980      id 1
crack 648.467      9131.98      649.414      9140.740      id 1
crack 649.414      9140.74      650.643      9149.300      id 1
crack 650.643      9149.3 652.632      9156.500      id 1
crack 652.632      9156.5 655.112      9161.990      id 1

```

```

;kimberlite_table.dat

```

```

;defines zone of kimberlite for material properties

```

```

table 1

```

```

table 1 553.898 9.158E3 556.882 9.149E3 558.938 9.142E3 562.07 9.132E3 564.087 9.121E3
562.889 9.109E3 566.308 9.099E3 569.108 9.089E3 572.669 9.077E3 573.882 9.069E3
575.876 9.059E3 575.646 9.047E3

```

```

table 1 575.887 9.039E3 575.641 9.031E3 572.186 9.022E3 572.464 9.017E3 580.772 9.008E3
586.98 9.004E3 592.884 8.998E3 597.282 8.995E3 601.543 8.989E3 605.072 8.981E3 619.298
8.979E3 627.878 8.989E3

```

```

table 1 628.385 8.994E3 628.735 8.999E3 630.031 9.007E3 629.355 9.013E3 626.85 9.022E3
625.717 9.029E3 626.451 9.037E3 627.547 9.044E3 628.594 9.053E3 629.52 9.06E3 632.075
9.067E3 634.293 9.076E3

```

```

table 1 634.644 9.082E3 637.804 9.089E3 642.359 9.097E3 643.77 9.109E3 647.309 9.122E3
648.467 9.132E3 649.414 9.141E3 650.643 9.149E3 652.632 9.156E3 655.112 9.162E3
553.898 9.158E3

```

```

;pit_outline.dat

```

```

;defines outline of A154 pit at Diavik

```

```

crack 510 9158 554 9158 join
crack 554 9158 655 9162 join
crack 655 9162 660 9162 join
crack 660 9162 664 9162 join
crack 664 9162 673 9162 join
crack 673 9162 678 9162 join
crack 678 9162 683 9186 join
crack 683 9186 687 9186 join
crack 687 9186 695 9188 join
crack 695 9188 731 9190 join
crack 731 9190 740 9215 join

```

```

crack 740 9215 773 9215 join
crack 773 9215 780 9219 join
crack 780 9219 787 9220 join
crack 787 9220 795 9250 join
crack 795 9250 810 9250 join
crack 810 9250 816 9266 join
crack 816 9266 819 9273 join
crack 819 9273 826 9275 join
crack 826 9275 854 9274 join
crack 854 9274 857 9279 join
crack 857 9279 863 9279 join
crack 863 9279 867 9309 join
crack 867 9309 888 9310 join
crack 888 9310 897 9339 join
crack 897 9339 907 9339 join
crack 907 9339 914 9358 join
crack 914 9358 952 9358 join
crack 952 9358 954 9362 join
crack 954 9362 958 9369 join
crack 958 9369 973 9369 join
crack 973 9369 976 9389 join
crack 976 9389 993 9389 join
crack 993 9389 995 9398 join
crack 995 9398 999 9401 join
crack 999 9401 1018 9401 join
crack 1018 9401 1028 9409 join
crack 1028 9409 1091 9411 join

```

```

;rockfall1.dat

```

```

;sets joints which defined rockfall scar at Diavik

```

```

crack 647 9129 648.7380937 9128.346885 join
crack 648.7380937 9128.346885 649.8171178 9125.785061 join
crack 649.8171178 9125.785061 650.5858827 9122.923408 join
crack 650.5858827 9122.923408 651.25 9119.757533 join

```

```

crack 649.4621587 9101.30741 647.3670666 9099.065144 join
crack 647.3670666 9099.065144 645.5804186 9096.261832 join
crack 645.5804186 9096.261832 644.8778245 9093.528213 join
crack 644.8778245 9093.528213 643.7837884 9091.194723 join
crack 643.7837884 9091.194723 641.7369621 9088.858025 join
crack 641.7369621 9088.858025 640.6821868 9085.962184 join
crack 640.6821868 9085.962184 640.4623028 9082.764725 join
crack 640.4623028 9082.764725 639.3789065 9079.616717 join
crack 639.3789065 9079.616717 637.5470067 9077.080065 join
crack 637.5470067 9077.080065 635.8259276 9074.777977 join
crack 635.8259276 9074.777977 634.5185141 9072.099058 join
crack 634.5185141 9072.099058 632 9069 join

```

```

;rockfall_tab.dat

```

```

;defines area to be removed to simulate rockfall

```

```

table 3

```


table 3 647 9129 648.7380937 9128.346885 649.8171178 9125.785061 650.5858827
9122.923408 651.25 9120.15
table 3 646.92 9098.32 645.5804186 9096.261832 644.8778245 9093.528213 643.7837884
9091.194723 641.7369621 9088.858025 640.6821868 9085.962184
table 3 640.4623028 9082.764725 639.3789065 9079.616717 637.5470067 9077.080065
635.8259276 9074.777977 634.5185141 9072.099058 632 9069 632 9100

;\voronoi.dat

;\creates Voronoi joints in Diavik models

table 2

table 2 626.876 9.009E3 625.717 9.029E3 626.451 9.037E3 627.547 9.044E3 628.594 9.053E3
629.52 9.06E3 632.075 9.067E3 634.293 9.076E3

table 2 634.644 9.082E3 637.804 9.089E3 642.359 9.097E3 643.77 9.109E3 647.309 9.122E3
648.467 9.132E3 649.414 9.141E3 650.643 9.149E3 652.632 9.156E3 655.112 9.162E3

table 2 665.4 9162 643.7 9050.4