Co-denitrification – role of soil moisture?

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Objectives

- Establish key drivers of denitrification and co-denitrification processes associated with urine patch deposition in soils.
- Identify key biochemical pathways governing the rate of co-denitrification.

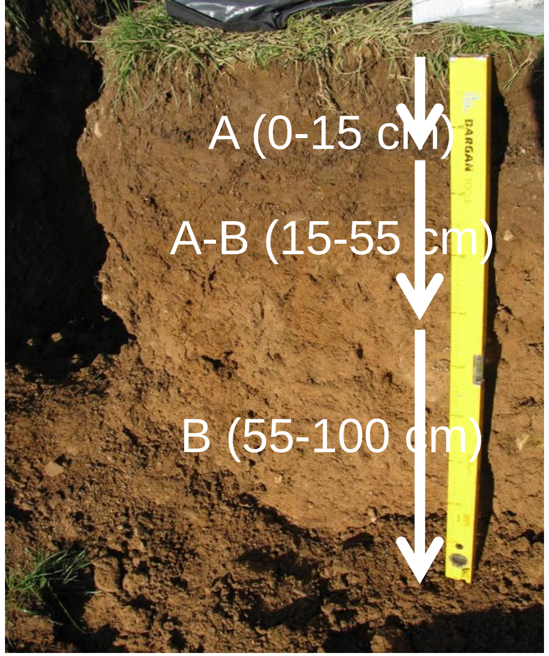
- **How important is soil moisture to codenitrification?**

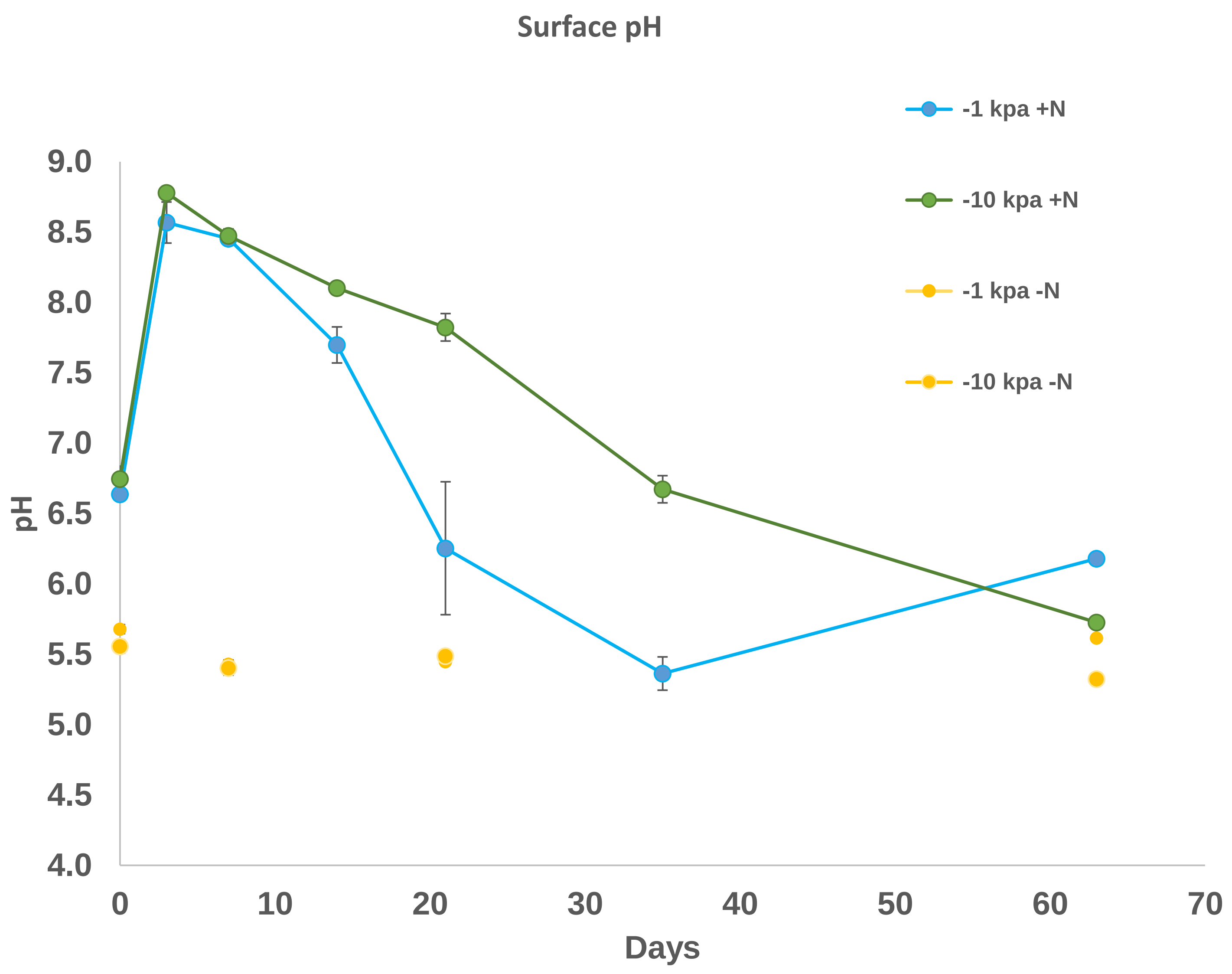
Experimental design

- Haplic Cambisol was repacked in soil cores: 1.1 Mg m^{-3}
- Two moisture contents (field capacity, -10 kPa and near saturation, -1.0 kPa)
- ± urea-^{15}N (50 atom% ^{15}N enrichment) to trace N_2 flux.
- Lab temperature ca 20°C

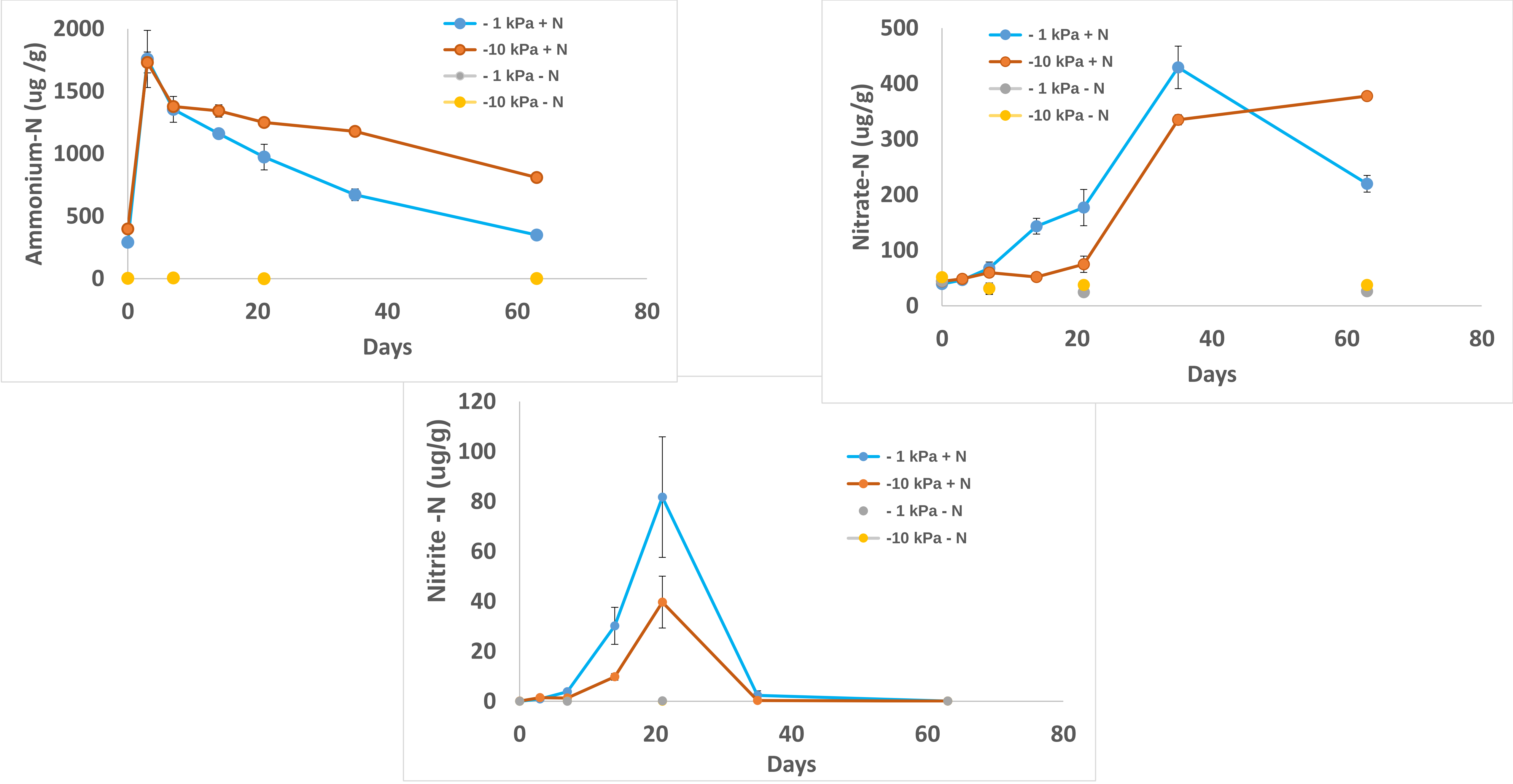
- Factorial design (replicated four times).

-1.0 kPa +N
-10 kPa +N
-1.0 kPa -N
-10 kPa -N

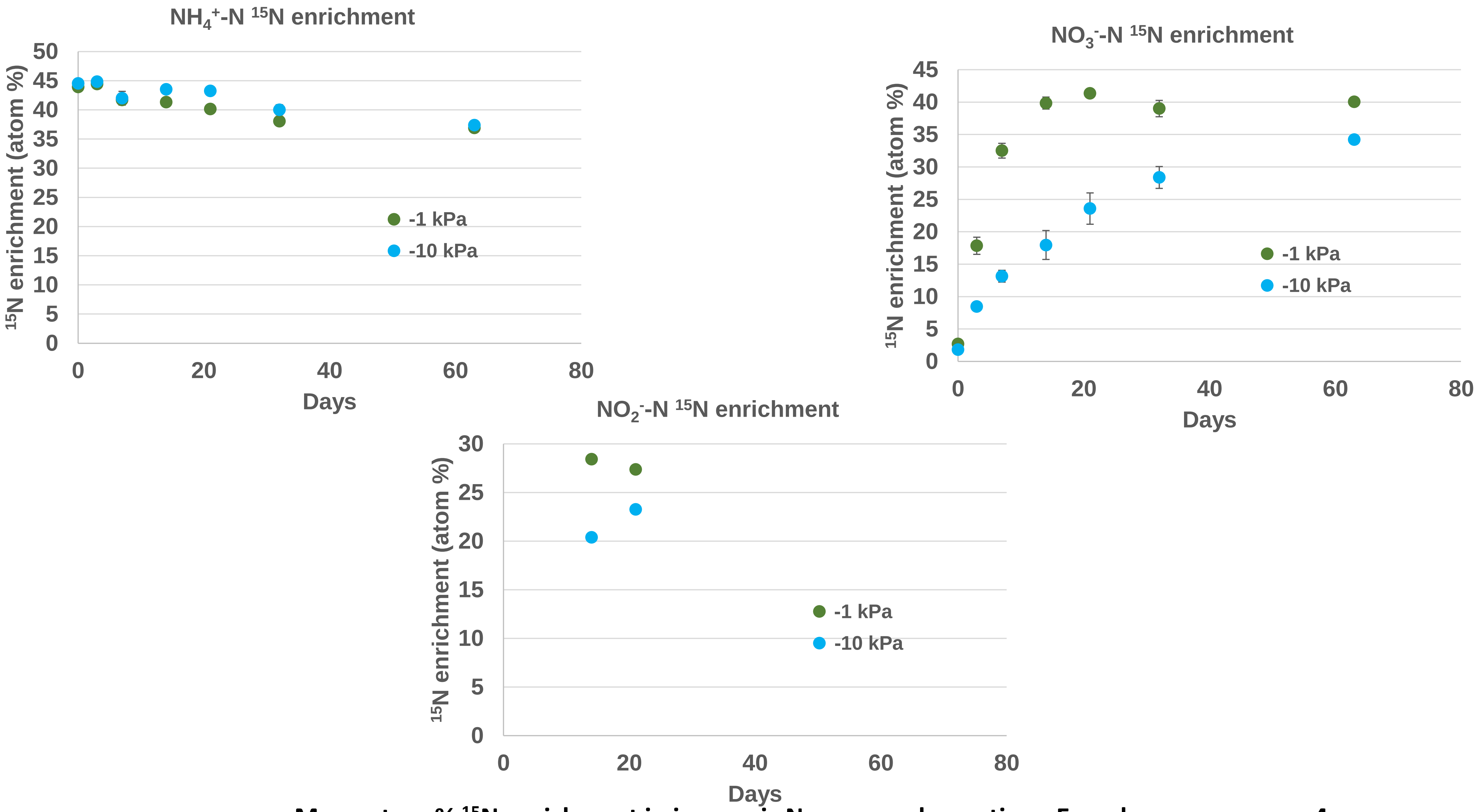




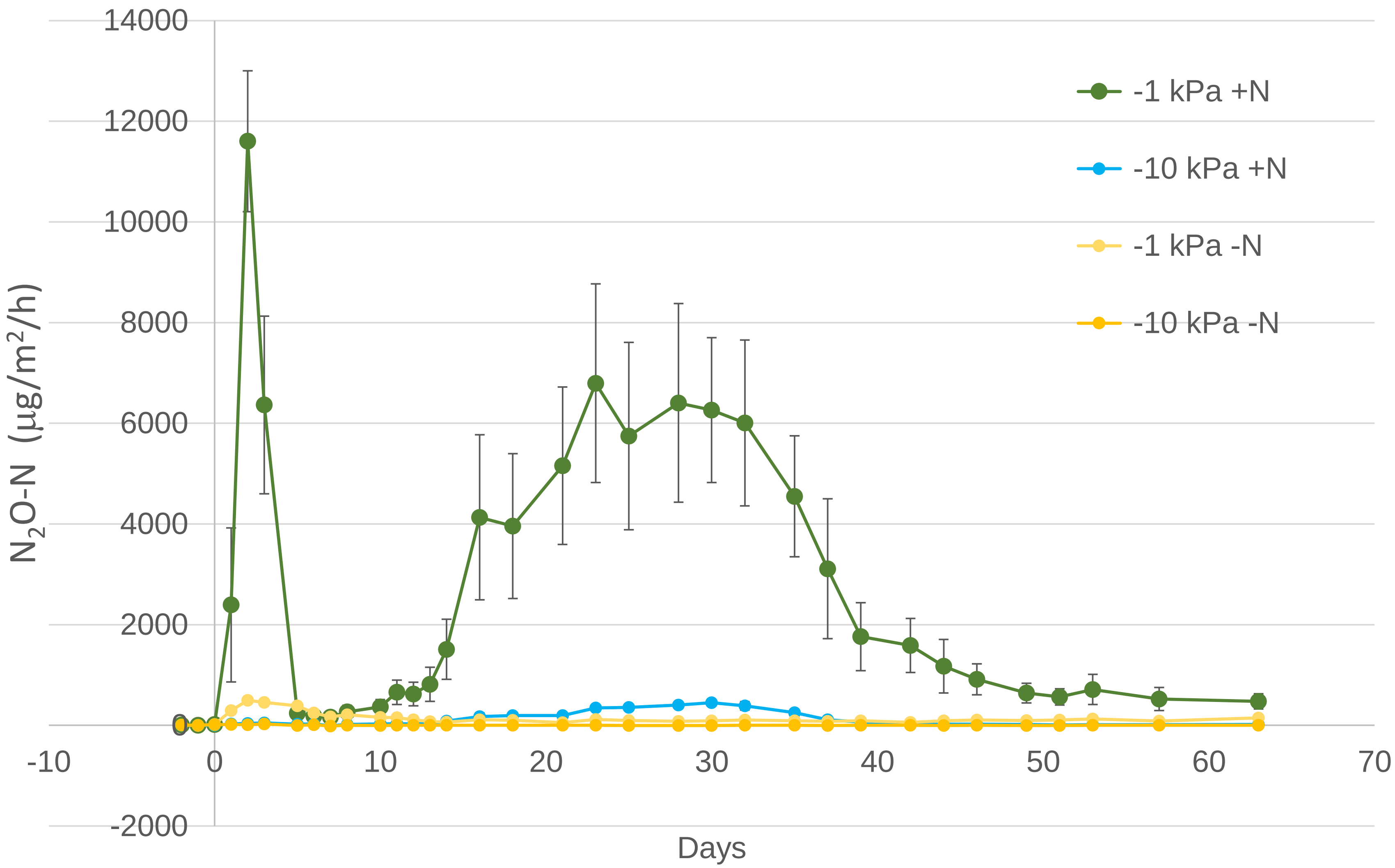
Soil surface pH over time. **Error bars = s.e.m, n = 4**



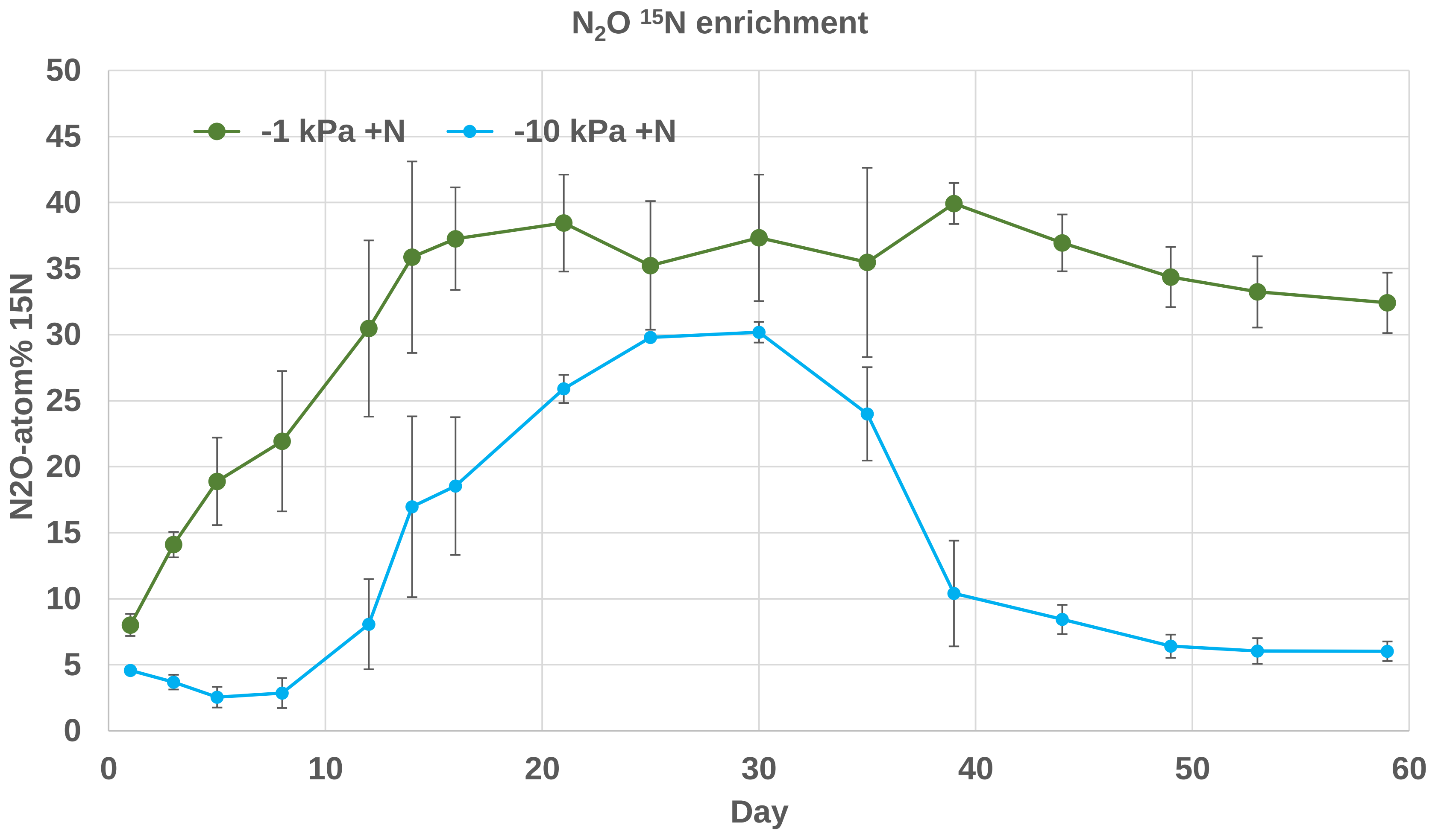
Soil inorganic N concentrations over time. Error bars = s.e.m, n = 4.



Mean atom % ^{15}N enrichment in inorganic N measured over time. Error bars = s.e.m, n = 4.



Mean N_2O-N fluxes over time. Error bars = s.e.m, n = 4.



N_2O ^{15}N enrichment. Error bars = s.e.m, n = 4

Calculating Co-denitrification

Labelled $^{15}N_2$ (50 atom%)

'true' denitrification → 15N – 15N $\Delta^{30}R$; 15N – 14N $\Delta^{29}R$

Co-denitrification → 15N – 14N $\Delta^{29}R$

- To calculate co-denitrification flux – need to measure the $\Delta^{29}R$ and $\Delta^{30}R$ beam areas and subtract out the $29N_2$ arising from 'true' denitrification

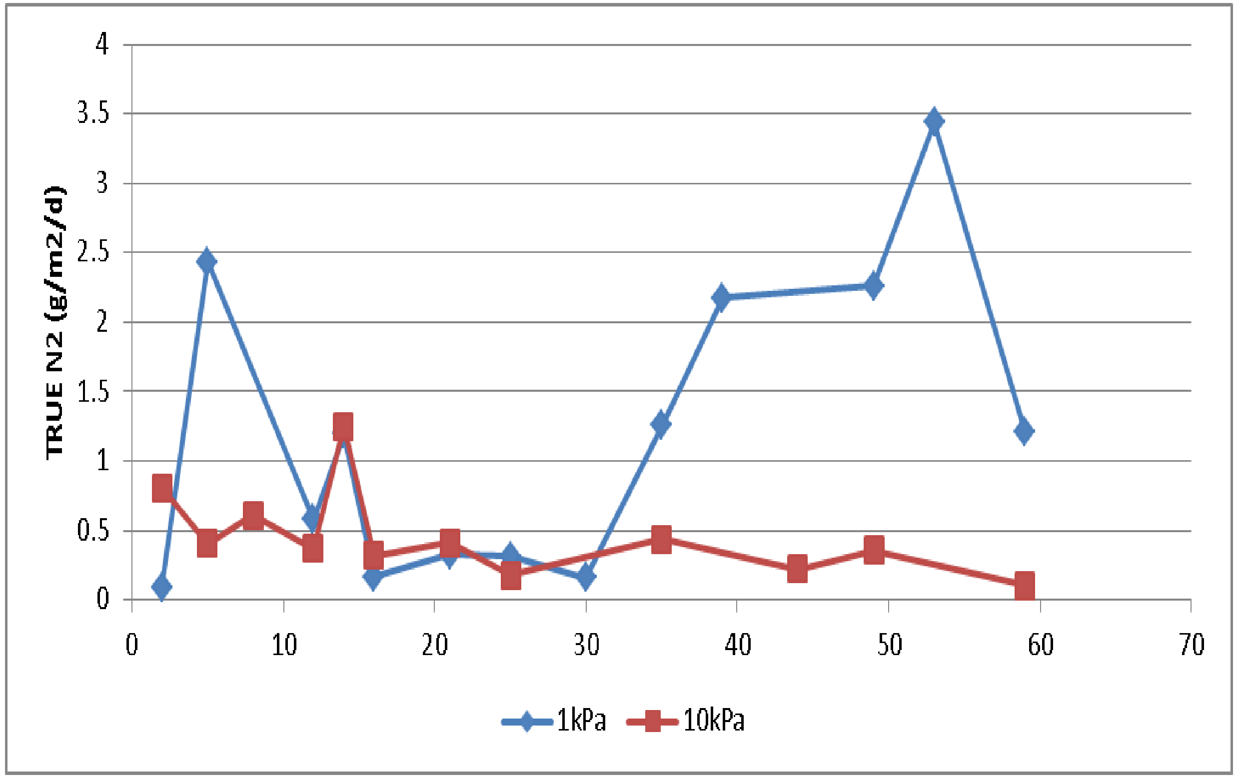
The fraction of the total moles of N_2 in the headspace from co-denitrification (dCD) is….

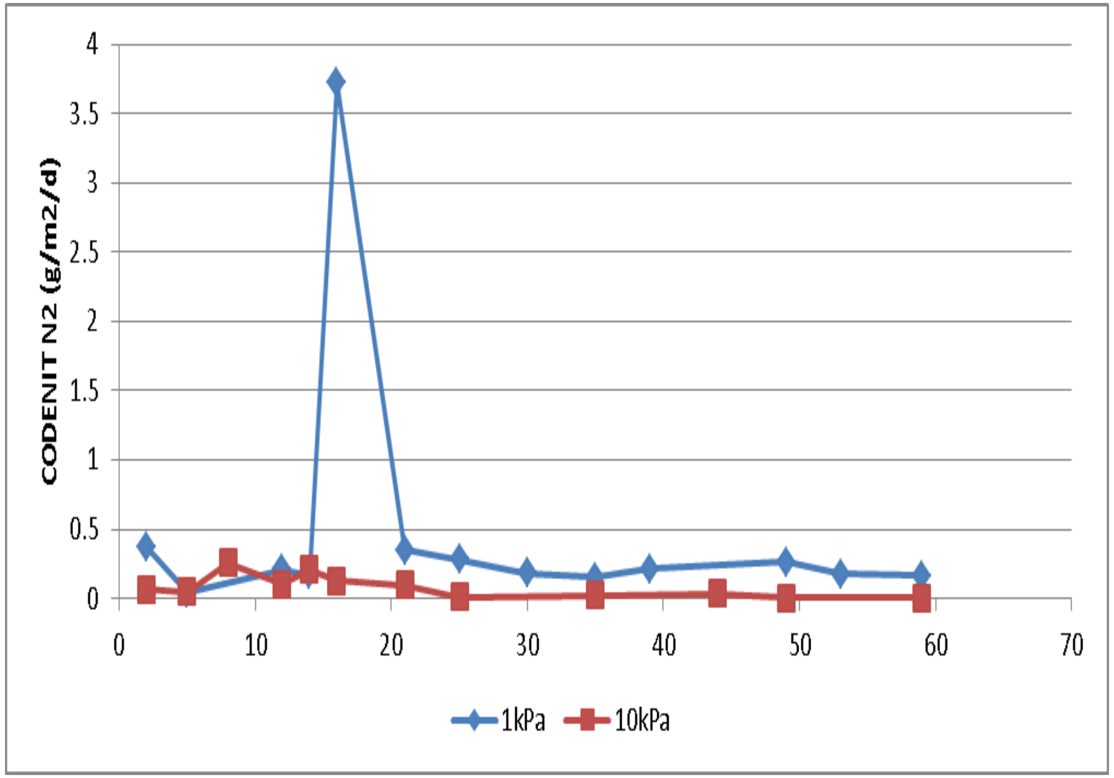
$$d_{CD} = -\Delta^{29}Rp_1^2/(-\Delta^{29}Rp_1^2+\Delta^{29}Rp_1p_2+q_1p_2-q_2p_1)$$

$\boldsymbol{p_1}$ (0.9963) and $\boldsymbol{q_1}$ (0.0037) are atom fractions of ^{14}N and ^{15}N in the natural abundance pool

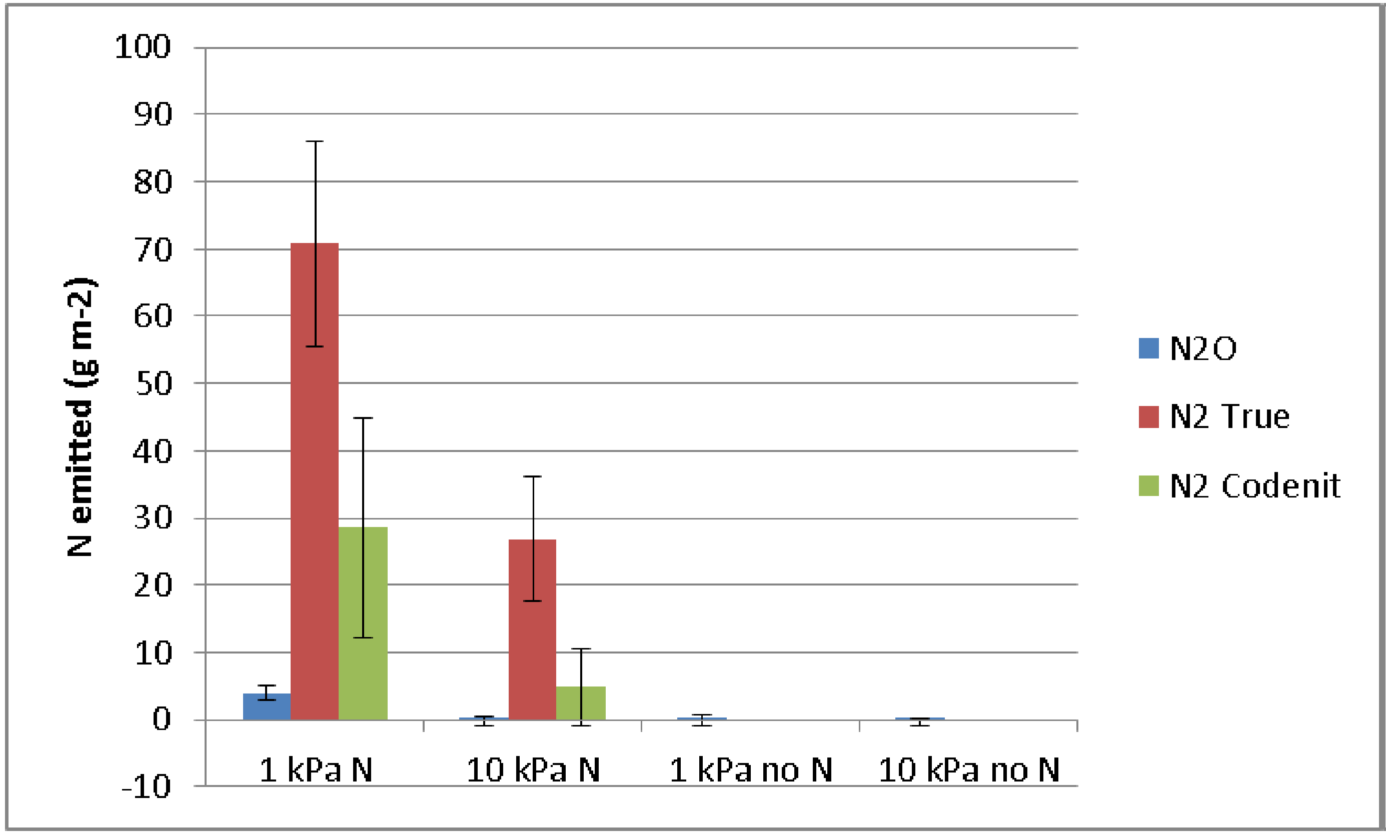
$\boldsymbol{p_2}$ and $\boldsymbol{q_2}$ are the atom fractions of ^{14}N and ^{15}N in the enriched pool

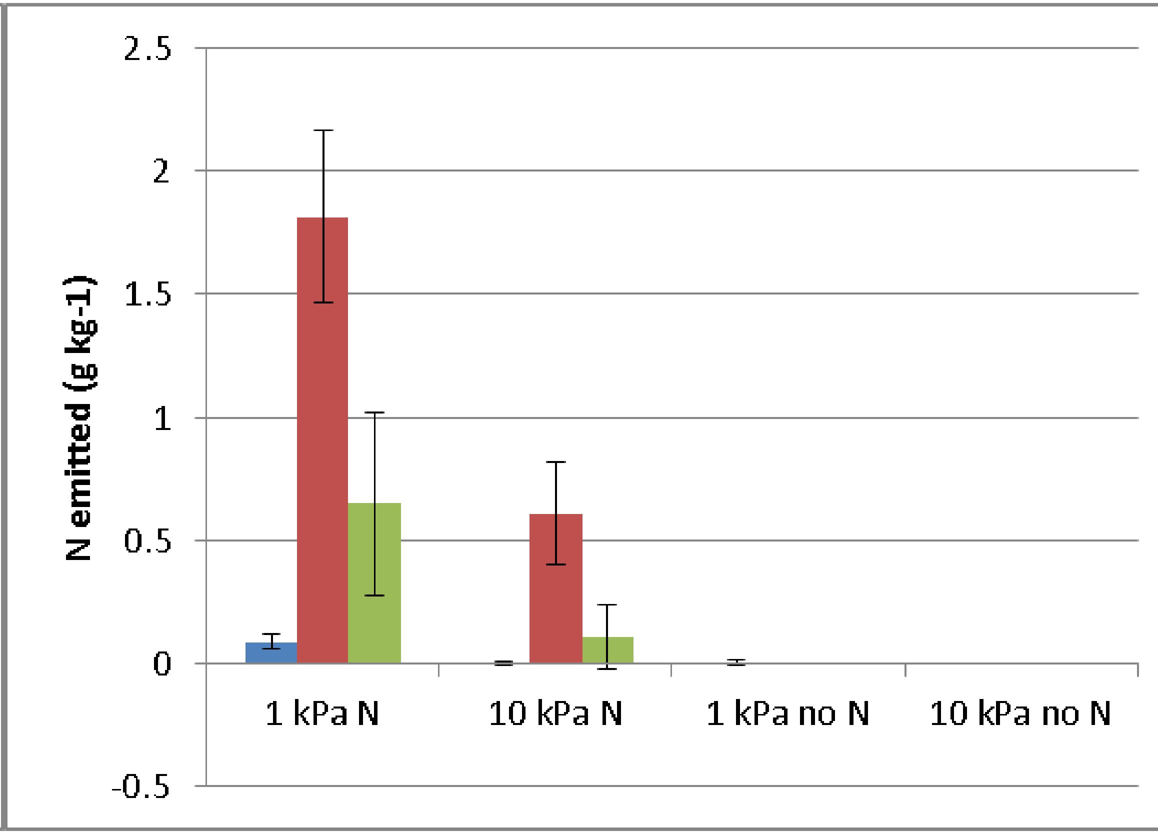
N_2 Fluxes


TRUE N2 (g/m2/d)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
1kPa
10kPa

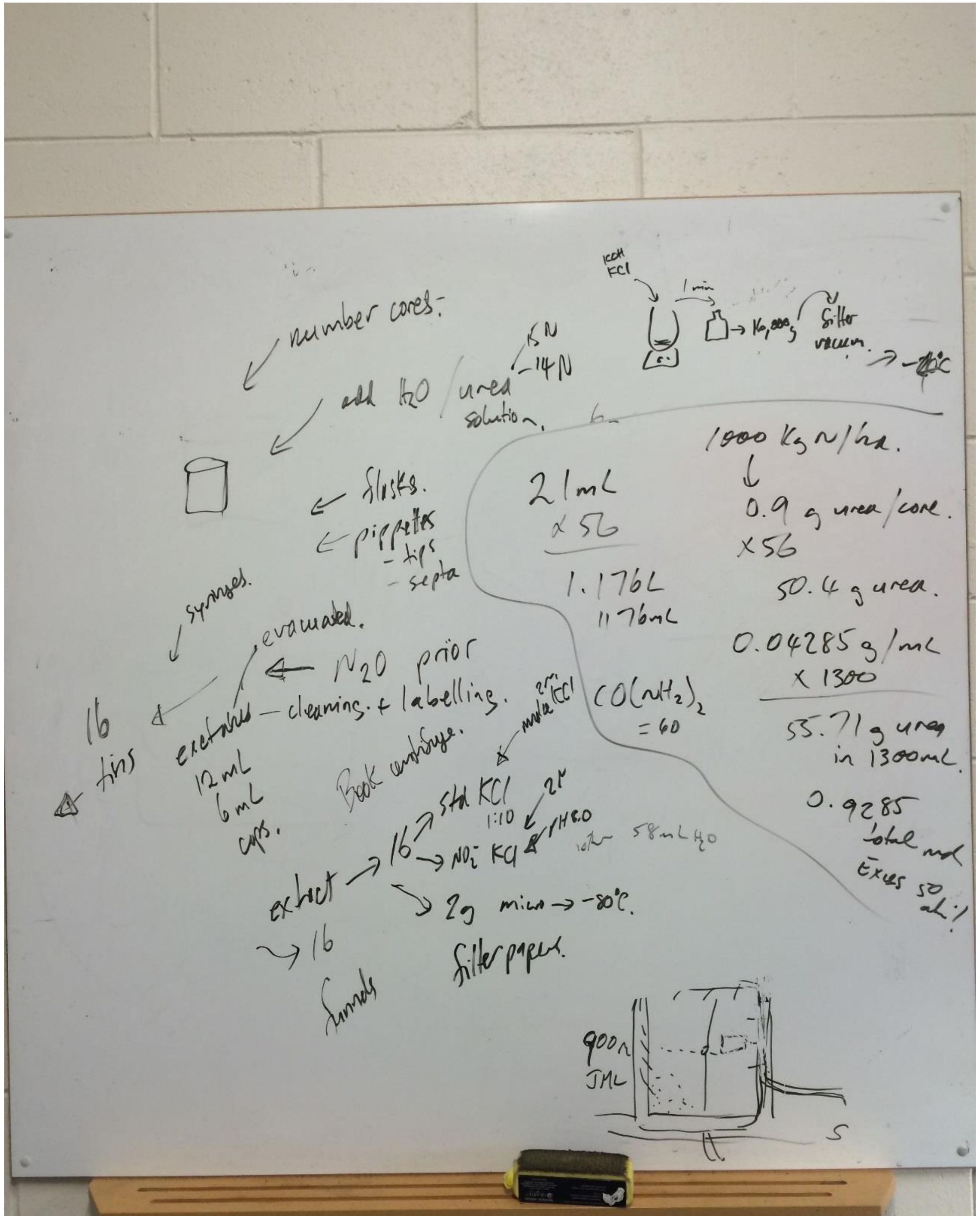

CODENIT N2 (g/m2/d)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
1kPa
10kPa

Cumulative N



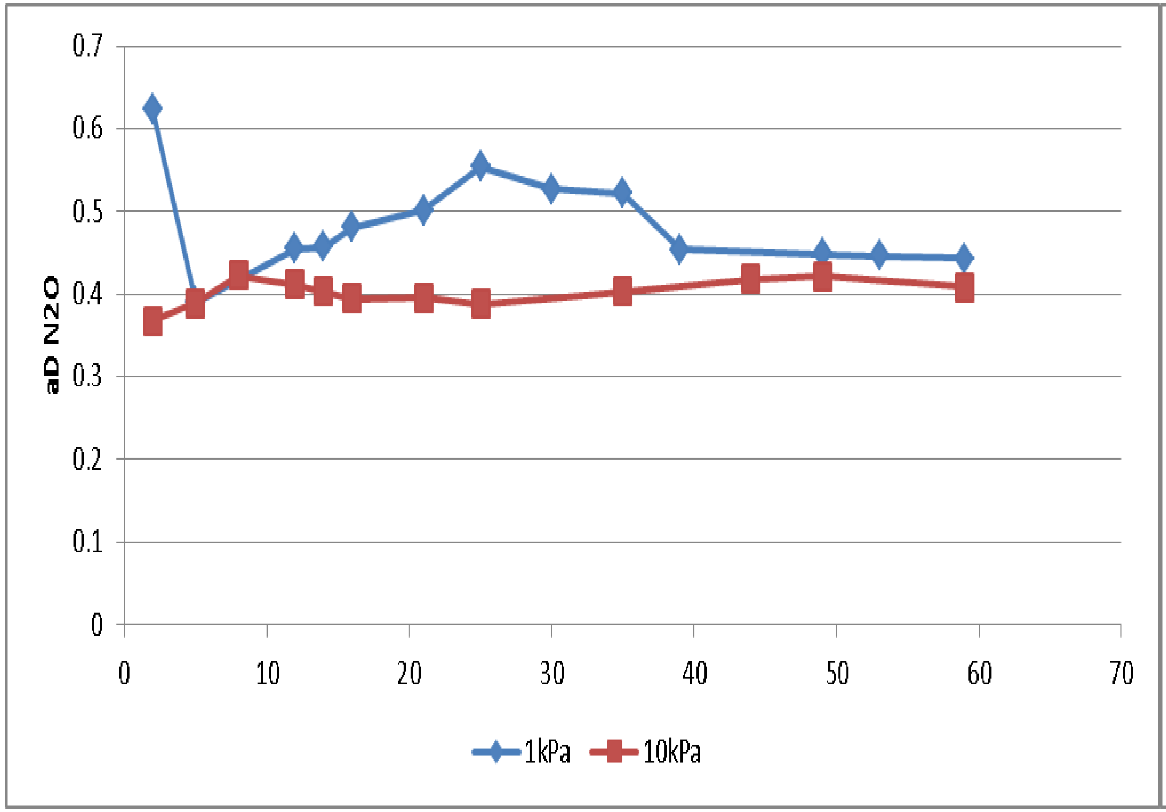


Thank you – questions?

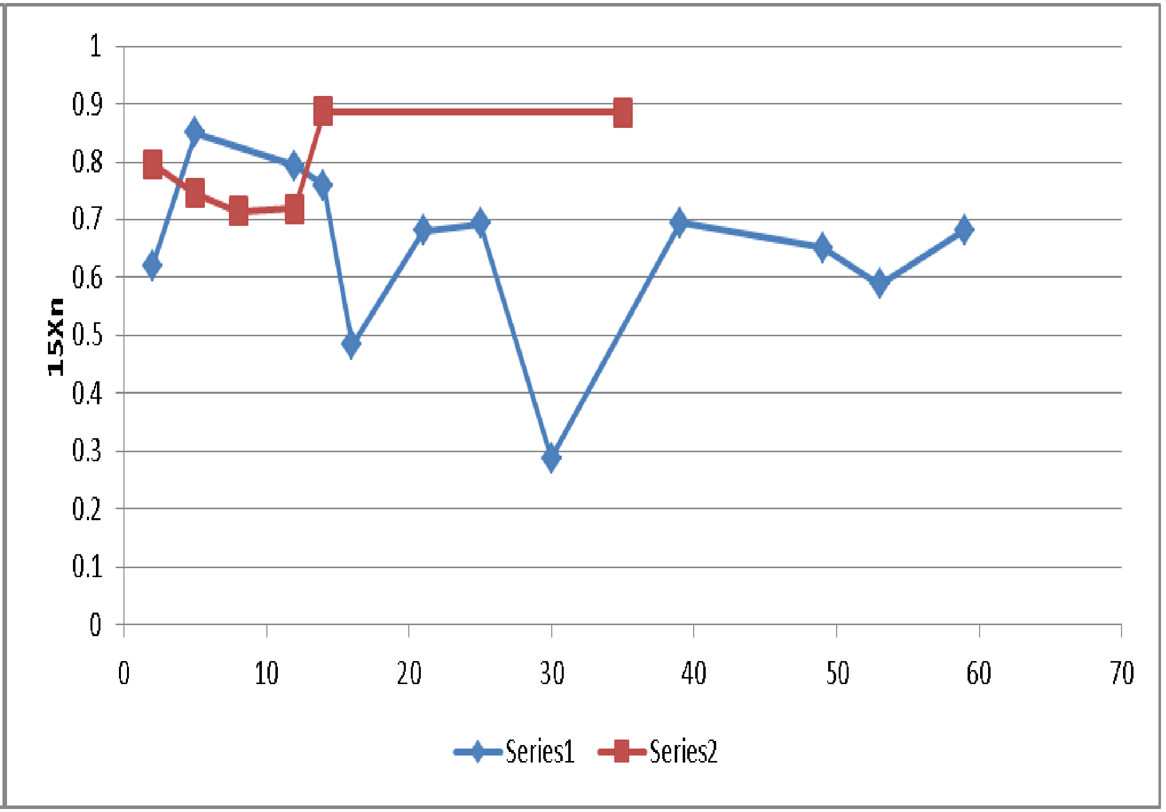


Denitrifying pool of enrichment

Assumes two pool source aD and aN

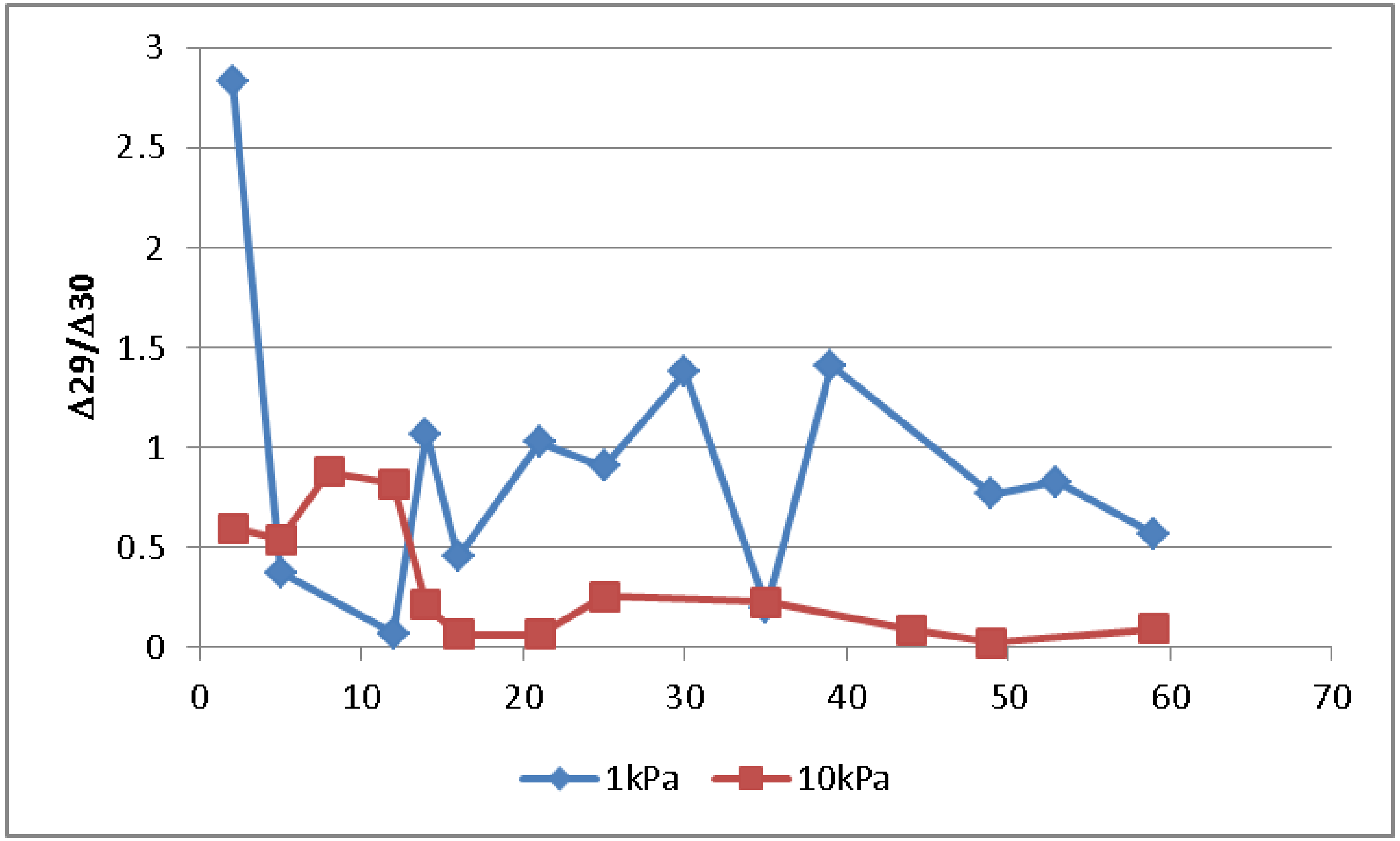


$\Delta^{29}R$ and $\Delta^{30}R$ used to calculate the enrichment of the denitrifying pool



Co-denitrification

- The sources of N_2O are apportioned into the fraction (d'_D) derived from the denitrifying pool of enrichment N_2O_{aD} and the fraction d'_N = (1 - d'_D) derived from the pool or pools at natural abundance
- From the contribution of 45 N2O and 46 N2O (and 29N, 30N) to the enrichment of this pool we can ascribe a proportion of the pool to co-denitrification



3
2.5
2
1.5
1
0.5
0
Δ29/Δ30
0
10
20
30
40
50
60
70
1kPa
10kPa