SARE water holding capacity calcs

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Data processing

NOTE: Calcs are loosely based on Agron479 lab, although I found that lab hard to follow.

I have my plot-treatment key (called *key*):

```
head(key)
```

```
## # A tibble: 6 x 8
##   site_name site_desc                sys_trt crop_trt cc_trt   rep  plot code
##   <chr>     <chr>                    <chr>   <chr>    <chr>  <dbl> <dbl> <chr>
## 1 Boyd42    Boyd Farm, soybean plots sil     soy      no         1     2 B42-p2
## 2 Boyd42    Boyd Farm, soybean plots sil     soy      no         2    11 B42-p11
## 3 Boyd42    Boyd Farm, soybean plots sil     soy      no         3    16 B42-p16
## 4 Boyd42    Boyd Farm, soybean plots sil     soy      no         4    20 B42-p20
## 5 Boyd42    Boyd Farm, soybean plots sil     soy      no         5    28 B42-p28
## 6 Boyd42    Boyd Farm, soybean plots sil     soy      cc         1     7 B42-p7
```

I have my raw data (called *datraw*):

```
head(datraw)
```

```
## # A tibble: 6 x 23
##   code  satsamp_g satwater_g cell_nu cylinder_g   atm `10_cm` `25_cm` `50_cm`
##   <chr>     <dbl>      <dbl> <chr>        <dbl> <dbl>   <dbl>   <dbl>   <dbl>
## 1 St-1~      859.       4.39 1a            46.1  48.9    48.5    53.8    49.2
## 2 St-3~      880.       4.68 2a            46.1  50.7    51.6    57.4    49.3
## 3 St-5~      848.       3.26 3a            46.1  50.2    50.6    56.9    49.6
## 4 St-7~      842.       6.49 4a            46.1  50.2    52.0    59.0    50.7
## 5 St-2~      856.       3.92 5a            46.2  50.4    51.8    55.5    48.9
## 6 St-4~      846.      19.3  6a            46.2  51.9    55.0    63.1    51.8
## # ... with 14 more variables: `100_cm` <dbl>, `200_cm` <dbl>, `500_cm` <dbl>,
## #   sampafter500_g <dbl>, drysoil_g <dbl>, ringpluscrap_g <dbl>, ring_g <dbl>,
## #   site_name <chr>, site_desc <chr>, sys_trt <chr>, crop_trt <chr>,
## #   cc_trt <chr>, rep <dbl>, plot <dbl>
```

1. Calculate the bulk density

```
dat1 <- datraw %>%
  # assume volume of soil sample is 347.50 cm3
  mutate(soilvol_cm3 = 347.5) %>%
  # calc bulk density based on dry weight of soil
  mutate(bulkden_gcm3 = drysoil_g / soilvol_cm3) %>%
  select(code, drysoil_g, bulkden_gcm3)

head(dat1)
```

```
## # A tibble: 6 x 3
##   code   drysoil_g bulkden_gcm3
```

```
##   <chr>      <dbl>        <dbl>
## 1 St-1no       526         1.51
## 2 St-3no       532         1.53
## 3 St-5no       512         1.47
## 4 St-7no       498         1.43
## 5 St-2cc       520         1.50
## 6 St-4cc       482         1.39
```

2. Calculate actual amount of water released at each pressure.

Note that pressure of 999 refers to the amount of water remaining in the soil after the 500 cm pressure was applied. This was determined by weighing the soil, drying it, then reweighing it.

```
dat2 <-
  datraw %>%
  mutate(
    w_0cm_g = satwater_g,
    w_2.5cm_g = atm - cylinder_g,
    w_10cm_g = `10_cm` - cylinder_g,
    w_25cm_g = `25_cm` - cylinder_g,
    w_50cm_g = `50_cm` - cylinder_g,
    w_100cm_g = `100_cm` - cylinder_g,
    w_200cm_g = `200_cm` - cylinder_g,
    w_500cm_g = `500_cm` - cylinder_g,
    w_999cm_g = sampafter500_g - ringpluscrap_g - drysoil_g
  ) %>%
  select(code, starts_with("w_"))

head(dat2)
```

```
## # A tibble: 6 x 10
##   code  w_0cm_g w_2.5cm_g w_10cm_g w_25cm_g w_50cm_g w_100cm_g w_200cm_g
##   <chr>   <dbl>     <dbl>    <dbl>    <dbl>    <dbl>     <dbl>     <dbl>
## 1 St-1~    4.39      2.73     2.35     7.63     3.08      4.08      4.68
## 2 St-3~    4.68      4.59     5.46    11.2      3.15      3.07      3.92
## 3 St-5~    3.26      4.12     4.53    10.8      3.5       3.26      3.92
## 4 St-7~    6.49      4.1      5.89    12.8      4.57      4.62      5.45
## 5 St-2~    3.92      4.2      5.67     9.34     2.76      3.73      4.46
## 6 St-4~   19.3       5.70     8.79    16.9      5.55      3.63      3.89
## # ... with 2 more variables: w_500cm_g <dbl>, w_999cm_g <dbl>
```

3. Gather into long form to get cumulatives.

```
dat3 <-
  dat2 %>%
  gather(w_0cm_g:w_999cm_g, key = press_cm, value = water_g) %>%
  separate(press_cm, into = c("water", "press_cm", "grams"), sep = "_") %>%
  select(-water, -grams) %>%
  # get pressure as a numeric value
  mutate(press_cm = parse_number(press_cm)) %>%
  # arrange within a sample
  group_by(code) %>%
  arrange(code, -press_cm) %>%
```

```
  # get cumulative water retained in soil at that pressure point (is this right?)
  mutate(cumwater_g = cumsum(water_g))

head(dat3)
```

```
## # A tibble: 6 x 4
## # Groups:   code [1]
##   code    press_cm water_g cumwater_g
##   <chr>      <dbl>   <dbl>      <dbl>
## 1 B42-p10      999  110.         110.
## 2 B42-p10      500    4.56       115.
## 3 B42-p10      200   12.6        128.
## 4 B42-p10      100    5.93       134.
## 5 B42-p10       50    8.03       142.
## 6 B42-p10       25    9.82       151.
```

4. Calculate water content of soil.

Divide the cumulative water released at each pressure by the weight of the dry soil (gravimetric water content). The gravimetric water content is converted to volumetric using the bulk density.

```
dat4 <-
  dat3 %>%
  left_join(dat1) %>%
  mutate(gtheta = cumwater_g / drysoil_g,
         vtheta = gtheta * bulkden_gcm3) %>%
  ungroup() %>%
  mutate_if(is.numeric, round, 3)

head(dat4)
```

```
## # A tibble: 6 x 8
##   code    press_cm water_g cumwater_g drysoil_g bulkden_gcm3 gtheta vtheta
##   <chr>      <dbl>   <dbl>      <dbl>     <dbl>        <dbl>  <dbl>  <dbl>
## 1 B42-p10      999  110.         110.      541.         1.56  0.204  0.318
## 2 B42-p10      500    4.56       115.      541.         1.56  0.213  0.331
## 3 B42-p10      200   12.6        128.      541.         1.56  0.236  0.367
## 4 B42-p10      100    5.93       134.      541.         1.56  0.247  0.384
## 5 B42-p10       50    8.03       142.      541.         1.56  0.262  0.407
## 6 B42-p10       25    9.82       151.      541.         1.56  0.28   0.436
```

5. Join the data with the key so I have treatment info.

```
dat5 <-
  dat4 %>%
  left_join(key) %>%
  select(code, site_name, sys_trt, cc_trt, rep,
         bulkden_gcm3, press_cm, gtheta, vtheta)

head(dat5)
```

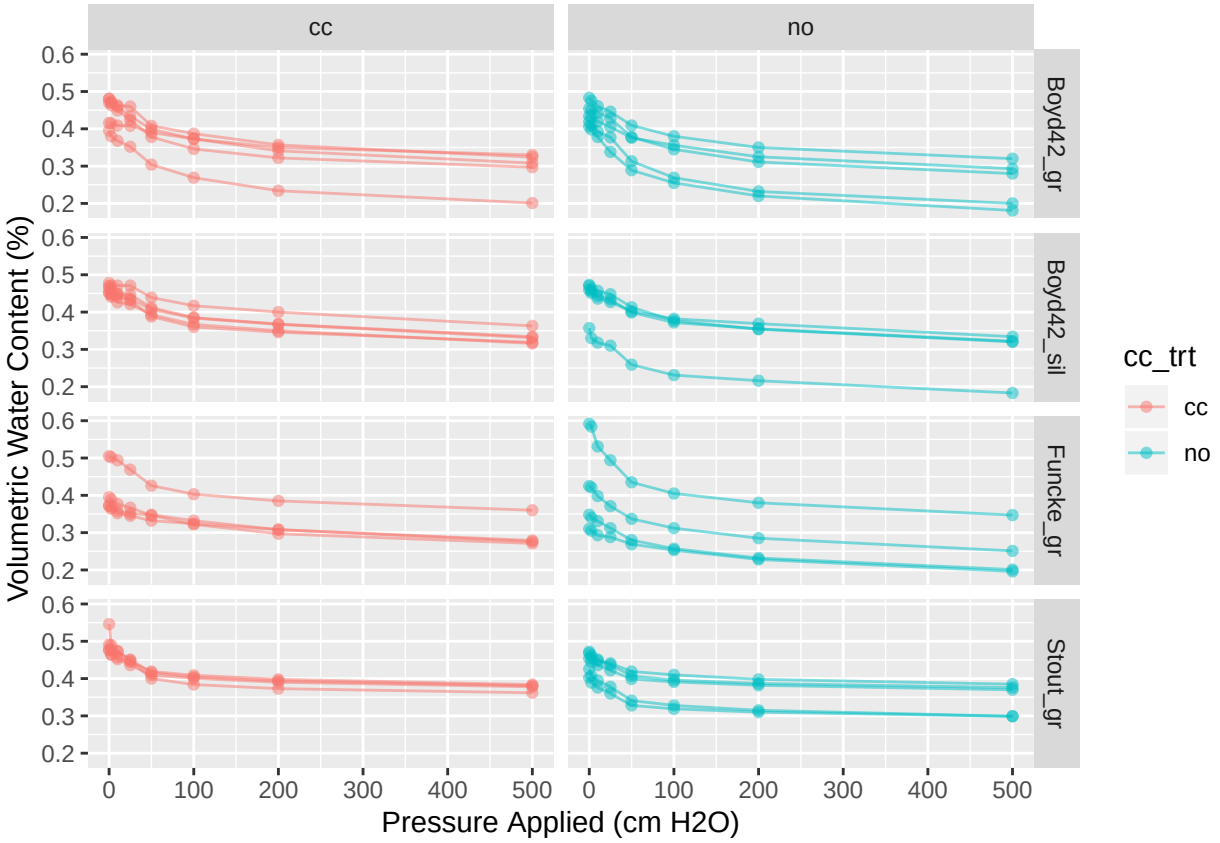
```
## # A tibble: 6 x 9
##   code    site_name sys_trt cc_trt   rep bulkden_gcm3 press_cm gtheta vtheta
##   <chr>   <chr>     <chr>   <chr>  <dbl>        <dbl>    <dbl>  <dbl>  <dbl>
```

```
## 1 B42-p10 Boyd42    sil     cc          2         1.56      999  0.204  0.318
## 2 B42-p10 Boyd42    sil     cc          2         1.56      500  0.213  0.331
## 3 B42-p10 Boyd42    sil     cc          2         1.56      200  0.236  0.367
## 4 B42-p10 Boyd42    sil     cc          2         1.56      100  0.247  0.384
## 5 B42-p10 Boyd42    sil     cc          2         1.56       50  0.262  0.407
## 6 B42-p10 Boyd42    sil     cc          2         1.56       25  0.28   0.436
```

Figures

Data for each cell, no transformation

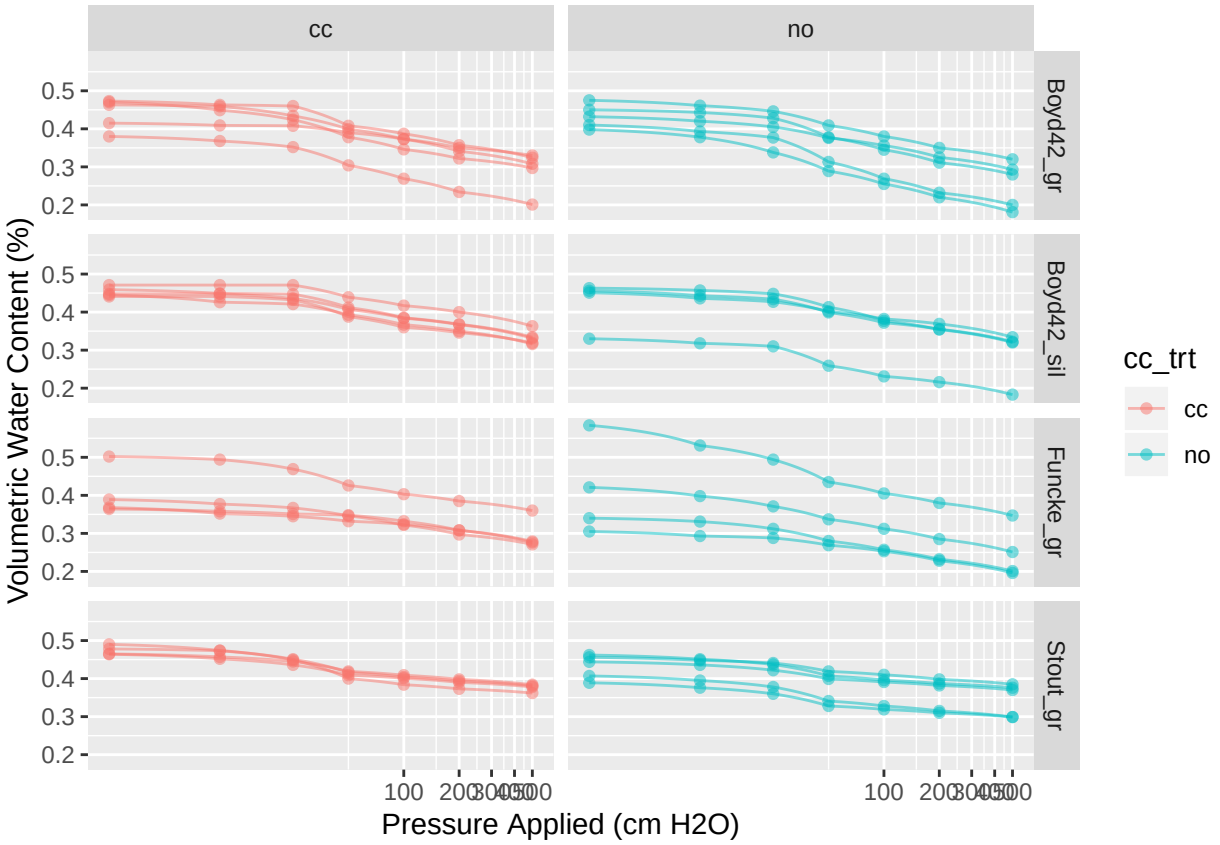
```
dat5 %>%
  # I don't think the water left after 500 cm ever comes into play (?)
  filter(press_cm != 999) %>%
  unite(site_name, sys_trt, col = "site_name") %>%
  ggplot(aes(press_cm, vtheta, color = cc_trt)) +
  geom_point(alpha = 0.5) +
  geom_line(alpha = 0.5, aes(group = code)) +
  facet_grid(site_name ~ cc_trt) +
  labs(x = "Pressure Applied (cm H2O)",
       y = "Volumetric Water Content (%)")
```



Data for each cell, log-scale

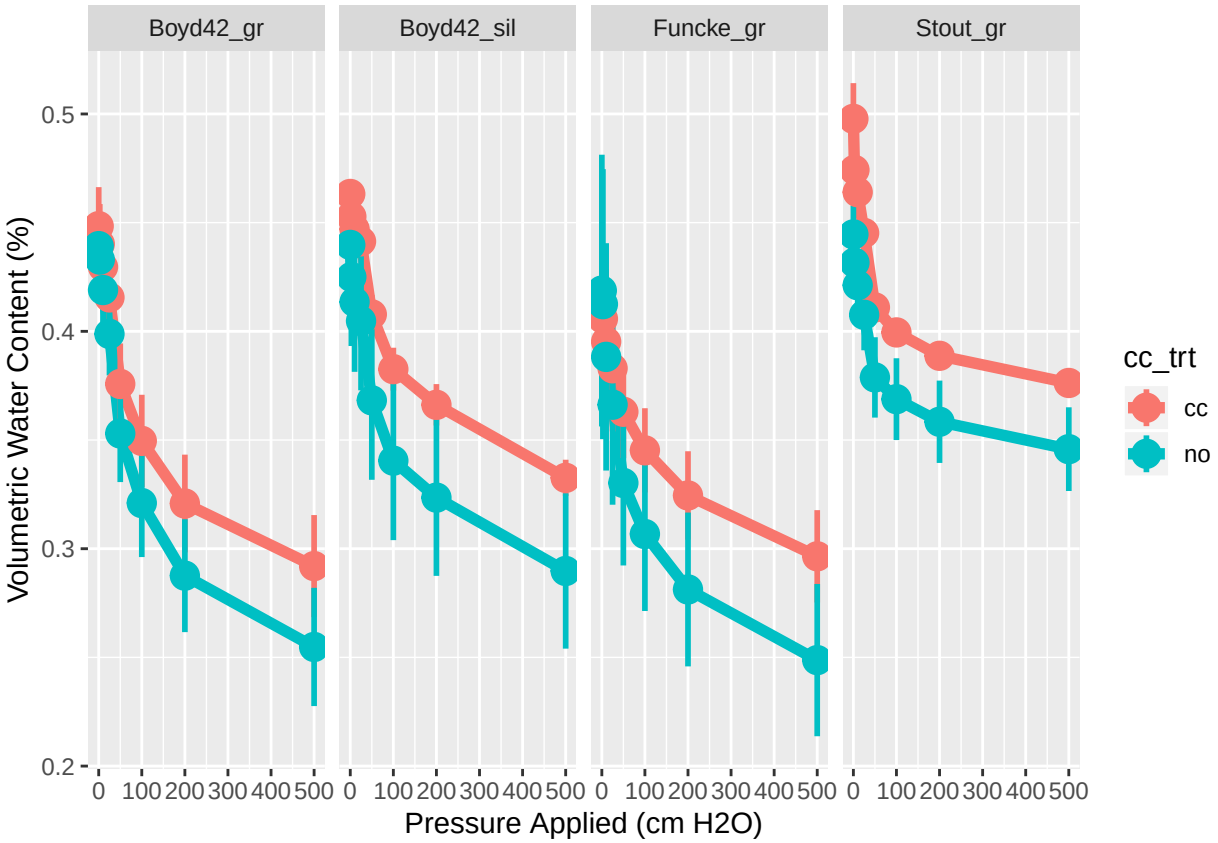
```
dat5 %>%
  # I don't think the water left after 500 cm ever comes into play (?)
  filter(press_cm != 999,
         press_cm != 0) %>% #--I can't take the log of 0
```

```
  unite(site_name, sys_trt, col = "site_name") %>%
  ggplot(aes(press_cm, vtheta, color = cc_trt)) +
  geom_point(alpha = 0.5) +
  geom_line(alpha = 0.5, aes(group = code)) +
  facet_grid(site_name ~ cc_trt) +
  labs(x = "Pressure Applied (cm H2O)",
       y = "Volumetric Water Content (%)") +
  coord_trans(x = "log10")
```



Data averaged for each treatment, no transformation

```
dat5 %>%
  # I don't think the water left after 500 cm ever comes into play (?)
  filter(press_cm != 999) %>%
  unite(site_name, sys_trt, col = "site_name") %>%
  ggplot(aes(press_cm, vtheta, color = cc_trt)) +
  stat_summary(fun.y = mean, geom="line", size = 2) +
  stat_summary(fun.data = "mean_se", size = 1) +
  facet_grid(. ~ site_name) +
  labs(x = "Pressure Applied (cm H2O)",
       y = "Volumetric Water Content (%)")
```


Boyd42_gr
Boyd42_sil
Funcke_gr
Stout_gr
Volumetric Water Content (%)
0.5
0.4
0.3
0.2
0
100
200
300
400
500
Pressure Applied (cm H2O)
cc_trt
cc
no