cs650calibration

November 30, 2017

0.1 Bring in libraries and dataframes and set indexes

```
In [1]: import datetime
        import pandas as pd
        import numpy as np
        import seaborn as sns
        import matplotlib.pyplot as plt
        import statsmodels.api as sm
        from statsmodels.formula.api import ols
        %matplotlib inline
```

```
In [2]: #Read in data
        AllData=pd.read_csv('D:\GitHubRepos\StonySoilLysimeters\Calibration\CS650Ca
                                        parse_dates=True, #tell the function to parse date
                                        dayfirst=True, #tell the function that the day is
                                        skiprows = [0,2,3], #leave out rows 1, 3 and 4 whi
                                        index_col = 0, #Use the first column, which is Dat
                                        na_values = 'NAN')

        #Bring in index data
        AllDataIndex=pd.read_csv('D:\GitHubRepos\StonySoilLysimeters\Calibration\Ca
                                        index_col = 0)
        #Apply indexes to data
        AllDataTransposed = AllData.transpose()
        AllDataIndexed = pd.concat([AllDataIndex,AllDataTransposed], axis=1)
        AllDataIndexed.index.name='ColumnHeader'
        AllDataIndexed.set_index(['Measurement','Treatment','Block','Sensor','Units
                                append=False, inplace=True)
        AllDataIndexed.sort(inplace=True)
        Data=AllDataIndexed.transpose()
        Data.index = Data.index.to_datetime()  ## for some reason the concat functi
```

0.2 Set time slice to graph

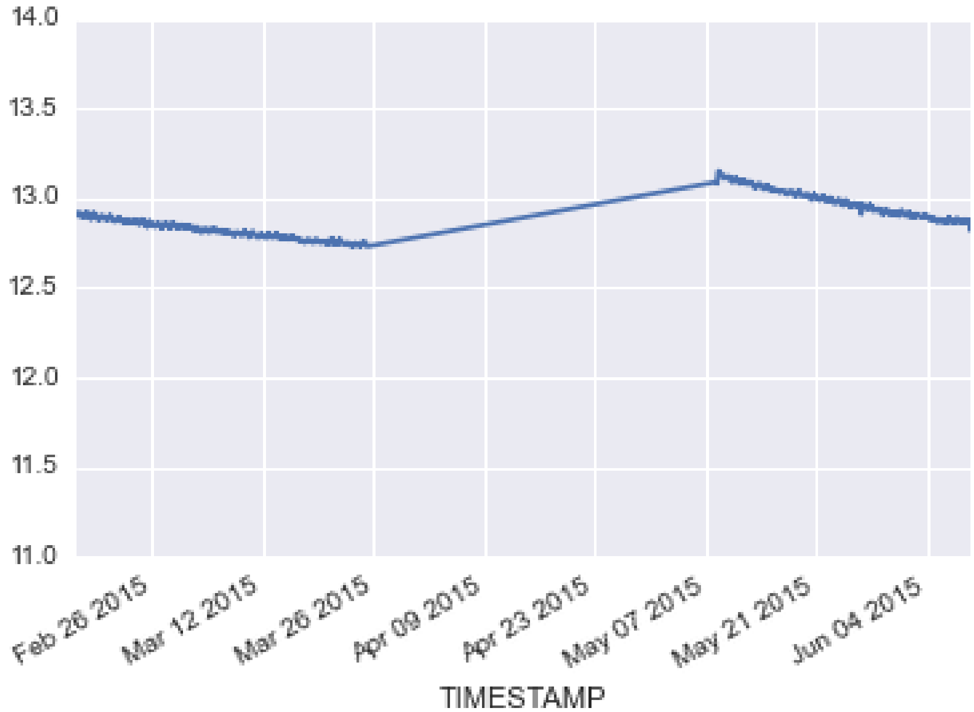
```
In [3]: from datetime import timedelta #Import function needed for doing date delta
        EndDate = Data.index.max()  #Set end of series as most recent date in file
        EndDateString = EndDate.strftime("%Y-%m-%d")  #Turn this to a string
        PlotDuration = 10
```

```
#Set the duration that you want to graph for
StartDate = EndDate - timedelta(weeks=PlotDuration)        #Set start date t
StartDateString = StartDate.strftime("%Y-%m-%d")            #Turn that into
EndDate
```

Out[3]: Timestamp('2015-06-09 13:00:00')

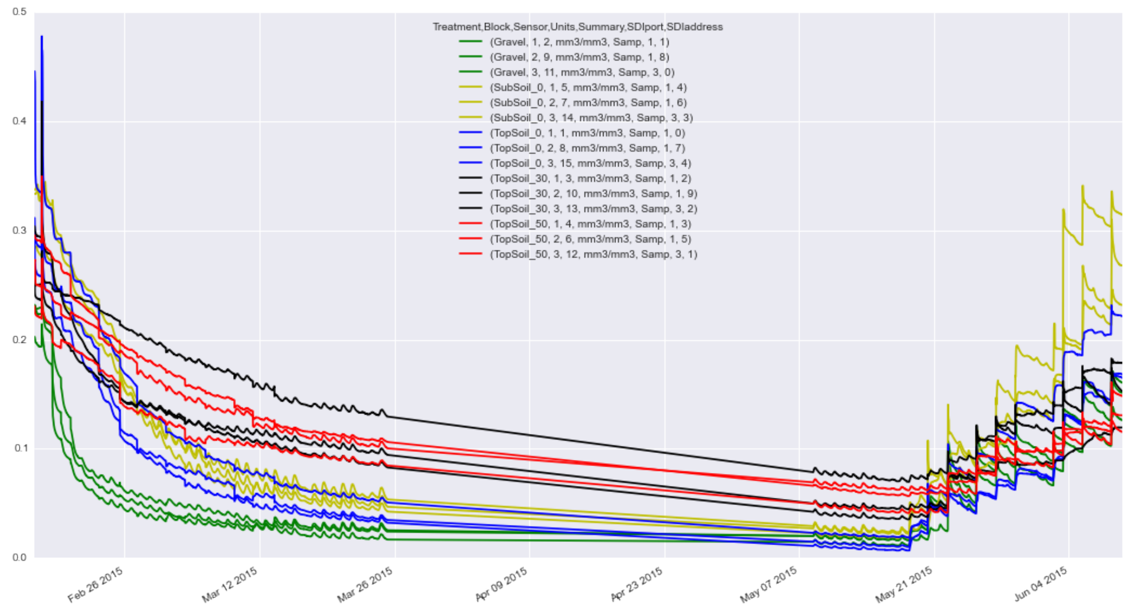
In [7]: `AllData['BattV_Avg'].plot(ylim=(11,14))`

Out[7]: <matplotlib.axes._subplots.AxesSubplot at 0x18568128>



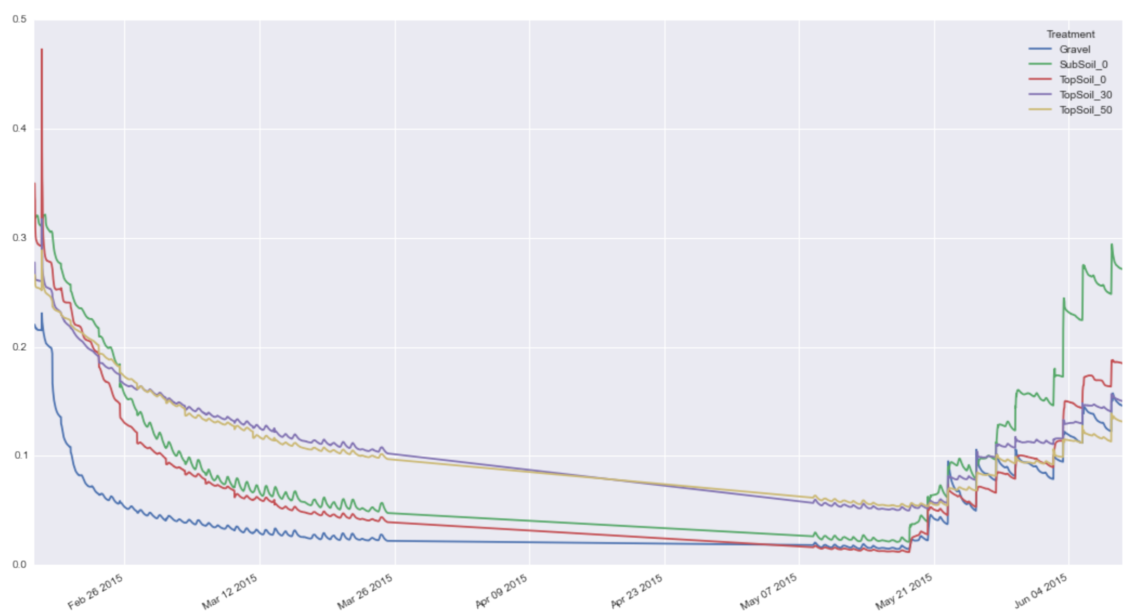
In [4]: `Data.VolumetricWaterContent.plot(figsize=(18,10),style=['g-','g-','g-','y-'`

Out[4]: <matplotlib.axes._subplots.AxesSubplot at 0x184e4668>




```
In [5]: DataMeans =  Data.VolumetricWaterContent.groupby(level=['Treatment'],axis=1
        DataMeans.plot(figsize=(18,10))
```

```
Out[5]: <matplotlib.axes._subplots.AxesSubplot at 0x188c7358>
```



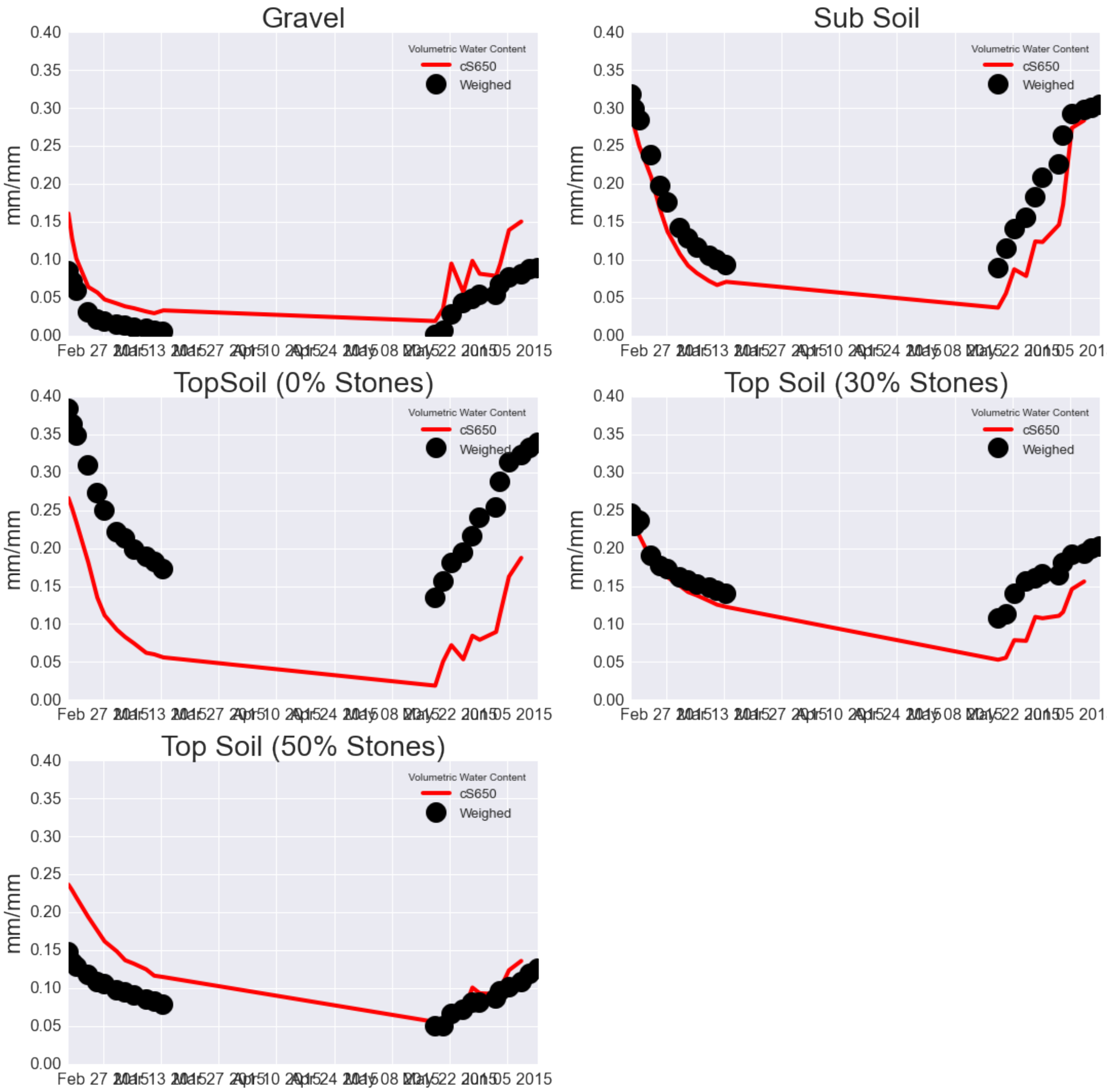
0.3 Bring in gravometric data

In [6]:
```
GravometricData = pd.read_excel('D:\GitHubRepos\StonySoilLysimeters\Calibra
GravometricData.set_index(['Plot','Trt','TrtNo', 'Rep'], inplace=True)
GWCData=GravometricData.transpose()  #Gravometric water content
Dates =   GWCData.index.tolist()     #List dates when containers were weighe
TDRData = Data.VolumetricWaterContent.ix[Dates,:]    #Set up a dateframe wit

DBD = pd.read_excel('D:\GitHubRepos\StonySoilLysimeters\Calibration\SoilWei
DBD.set_index('Plot', inplace=True)
DBDData = DBD.transpose()  #Soil Dry Bulk Density Data frame
```

0.4 Calculated volumetric water content from gravometric water content and soil dry bulk density

In [7]:
```
VWCData = pd.DataFrame(index = GWCData.index, columns = GWCData.columns)   #
for X in range (1,16):
    Plot = 'P'+ np.str(X)
    VWCData.ix[:,Plot] = GWCData.ix[:,X-1].multiply(DBDData.ix['DBD',Plot])
```

In [8]:
```
#calculate mean water contents from TDR
TDRMeans = TDRData.groupby(level =['Treatment'], axis=1).mean()

#calculate mean gravometric water content
VWCMeans = VWCData.groupby(level=['Trt'],axis=1).mean()


Fig = plt.figure(figsize=(18, 18))

def MakePlot(Position, Horizon, HorizonLabel, Ymax):
        Fig.add_subplot(3,2,Position, color_cycle=['r','k'])
        plt.title(HorizonLabel, fontsize=28);
        plt.plot(TDRMeans.index, TDRMeans.ix[:,Horizon], '-', linewidth = 4
        plt.plot(VWCMeans.index, VWCMeans.ix[:,Horizon], 'o', markersize=20
        plt.ylabel('mm/mm', fontsize=22);
        plt.tick_params(labelsize=16);
        plt.ylim(0,Ymax);
        plt.legend(loc=1, fontsize=13, title='Volumetric Water Content')
        return;

MakePlot(1,'Gravel','Gravel', 0.4)
MakePlot(2, 'SubSoil_0', 'Sub Soil', 0.4)
MakePlot(3, 'TopSoil_0', 'TopSoil (0% Stones)', 0.4)
MakePlot(4, 'TopSoil_30','Top Soil (30% Stones)', 0.4)
MakePlot(5, 'TopSoil_50', 'Top Soil (50% Stones)', 0.4)
```



0.5 Regress the data for each treatment to get callibrations

```
In [9]: HorizonLables = pd.Series(VWCMeans.columns,name='Horizon')
        #Add in two horizon labels for sub soil horizions that were not included i
        HorizonLables[5] = 'SubSoil_30'
        HorizonLables[6] = 'SubSoil_50'
        HorizonCoefficients = pd.DataFrame(0,index=HorizonLables,columns=['Slope','
```

```
In [10]: TDRMeans.Gravel[:'2015-04-01']
```

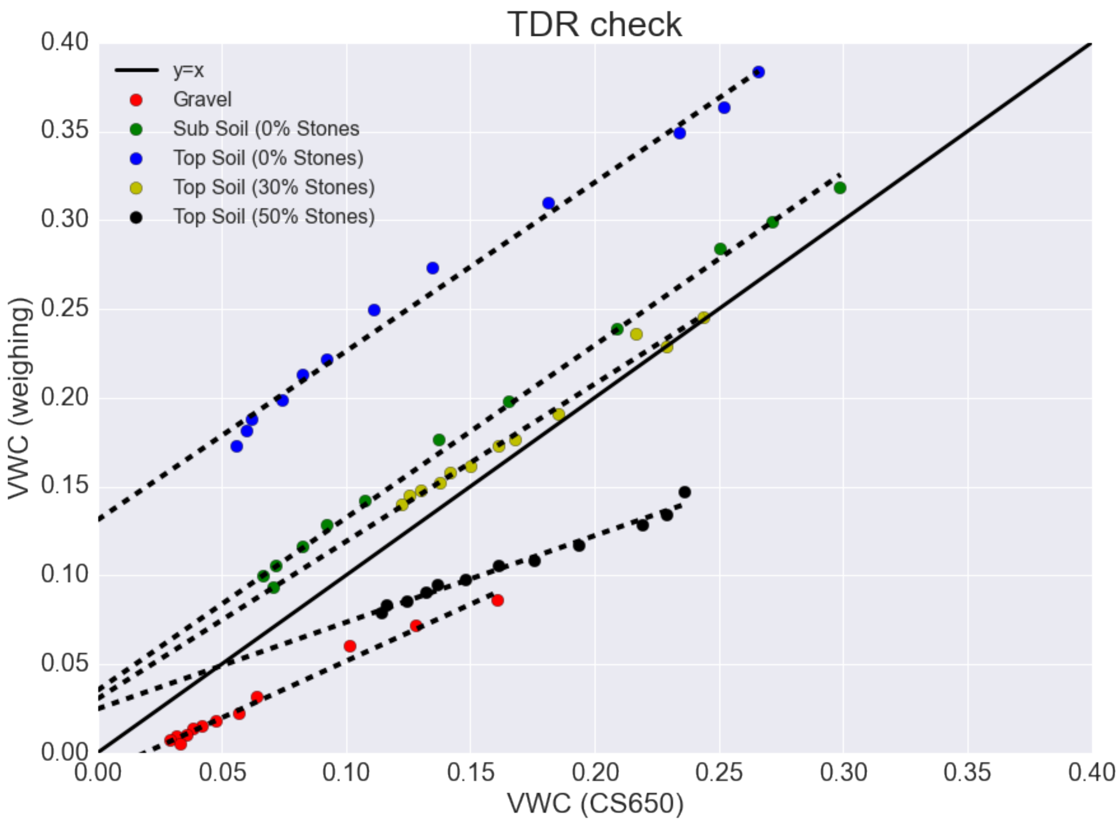
```
Out[10]: 2015-02-18 13:30:00    0.161100
         2015-02-19 11:00:00    0.128200
         2015-02-20 11:30:00    0.101733
         2015-02-23 09:00:00    0.064333
```

```
2015-02-25 14:00:00    0.057000
2015-02-27 08:30:00    0.047800
2015-03-02 08:00:00    0.042433
2015-03-04 08:00:00    0.038667
2015-03-06 11:00:00    0.036233
2015-03-09 10:30:00    0.031900
2015-03-11 09:00:00    0.029600
2015-03-13 14:30:00    0.033367
Name: Gravel, dtype: float64
```

```
In [11]: #Draw a graph with mean data
         plt.figure(figsize=(14, 10));
         plt.title('TDR check', fontsize=28);
         plt.scatter(TDRMeans.Gravel[:'2015-04-01'], VWCMeans.Gravel[:'2015-04-01']
         plt.scatter(TDRMeans.SubSoil_0[:'2015-04-01'], VWCMeans.SubSoil_0[:'2015-0
         plt.scatter(TDRMeans.TopSoil_0[:'2015-04-01'], VWCMeans.TopSoil_0[:'2015-0
         plt.scatter(TDRMeans.TopSoil_30[:'2015-04-01'], VWCMeans.TopSoil_30[:'2015
         plt.scatter(TDRMeans.TopSoil_50[:'2015-04-01'], VWCMeans.TopSoil_50[:'2015
         plt.plot([0,0.5], [0,0.5], 'k-', linewidth = 3, label = 'y=x')
         plt.ylim(0,0.4);
         plt.xlim(0,0.4);
         plt.xlabel('VWC (CS650)', fontsize=22);
         plt.ylabel('VWC (weighing)', fontsize=22);
         plt.tick_params(labelsize=20)

         #Fit regressions to each treatment for the dry down data
         for X in range(0,5):
             Treatment = HorizonLables[X]
             ModTemp = sm.regression.linear_model.OLS(VWCMeans.ix[:'2015-04-01',Tre
                                                      sm.add_constant(TDRMeans.ix[:'2015
                                                      missing='drop',
                                                      hasconst=False)
             RegCalib = ModTemp.fit();  # fit models parameters

         #Add regressions onto graph
             xmin = 0#TDRMeans.ix[:'2015-04-01',Treatment].min()
             xmax = TDRMeans.ix[:'2015-04-01',Treatment].max()
             Regres = RegCalib
             VWC_x = [xmin,xmax];
             VWC_y_fits = [Regres.params.const + xmin * Regres.params.get_value(Tre
             plt.plot(VWC_x, VWC_y_fits, 'k--', lw=4);

         #Assign coeffients to dataframe
             HorizonCoefficients.ix[Treatment,'Slope'] = Regres.params.get_value(Tr
             HorizonCoefficients.ix[Treatment,'Intercept'] = Regres.params.const

         #Add wet up data onto graph
         #plt.scatter(TDRMeans.Gravel['2015-04-01':], VWCMeans.Gravel['2015-04-01'
```

```
#plt.scatter(TDRMeans.SubSoil_0['2015-04-01':], VWCMeans.SubSoil_0['2015-0
#plt.scatter(TDRMeans.TopSoil_0['2015-04-01':], VWCMeans.TopSoil_0['2015-0
#plt.scatter(TDRMeans.TopSoil_30['2015-04-01':], VWCMeans.TopSoil_30['2015
#plt.scatter(TDRMeans.TopSoil_50['2015-04-01':], VWCMeans.TopSoil_50['2015

plt.legend(loc=0, fontsize=16)
```

```
Out[11]: <matplotlib.legend.Legend at 0x1c06b748>
```




```
In [12]: VWCData.index = VWCData.index.to_datetime()
```

```
In [13]: VWCDataUpper = VWCData[:'2015-04-01'].max(axis=0)
         VWCDataLower = VWCData[:'2015-04-01'].min(axis=0)
         PAWC = VWCDataUpper - VWCDataLower
         PAWCLiters = PAWC * 35 # crates are 35 liters
         RewettingVolumes = PAWCLiters/5
         RewettingVolumes.groupby(level='Trt').mean()
```

```
Out[13]: Trt
         Gravel         0.566727
         SubSoil_0      1.578643
         TopSoil_0      1.471917
```

```
TopSoil_30    0.757243
TopSoil_50    0.476932
dtype: float64
```

In [14]:
```
HorizonLL = VWCDataLower.groupby(level='Trt').mean()
```

In [23]:
```
#Estimate slope for sub soil horizions in relation to the stone effect fro
HorizonCoefficients.ix['SubSoil_30','Slope'] = 0.75#HorizonCoefficients.ix
#(HorizonCoefficients.ix['TopSoil_30','Slope']-HorizonCoefficients.ix['Top
HorizonCoefficients.ix['SubSoil_50','Slope'] = 0.55#HorizonCoefficients.ix
#(HorizonCoefficients.ix['TopSoil_50','Slope']-HorizonCoefficients.ix['Top
HorizonCoefficients.ix['SubSoil_30','Intercept'] = 0#HorizonCoefficients.i
#(HorizonCoefficients.ix['TopSoil_30','Intercept']-HorizonCoefficients.ix[
HorizonCoefficients.ix['SubSoil_50','Intercept'] = 0#HorizonCoefficients.i
#(HorizonCoefficients.ix['TopSoil_50','Intercept']-HorizonCoefficients.ix[

#Set Lower limit values for each horizon type
HorizonCoefficients.LL = HorizonLL  #use lowest measured values for observ
HorizonCoefficients.ix['SubSoil_30','LL'] = HorizonCoefficients.ix['SubSoi
#Estamate for stony sub soils based on stone free value and stone volume
HorizonCoefficients.ix['SubSoil_50','LL'] = HorizonCoefficients.ix['SubSoi

#Set drained upper limits for each horizion type
HorizonCoefficients.ix['Gravel','DUL'] = 0.12
SubSoilDUL = 0.32
TopSoilDUL = 0.35

HorizonCoefficients.ix['SubSoil_0','DUL'] = SubSoilDUL
HorizonCoefficients.ix['TopSoil_0','DUL'] = TopSoilDUL
HorizonCoefficients.ix['SubSoil_30','DUL'] = SubSoilDUL * 0.7
HorizonCoefficients.ix['TopSoil_30','DUL'] = TopSoilDUL * 0.7
HorizonCoefficients.ix['SubSoil_50','DUL'] = SubSoilDUL * 0.5
HorizonCoefficients.ix['TopSoil_50','DUL'] = TopSoilDUL * 0.5
```

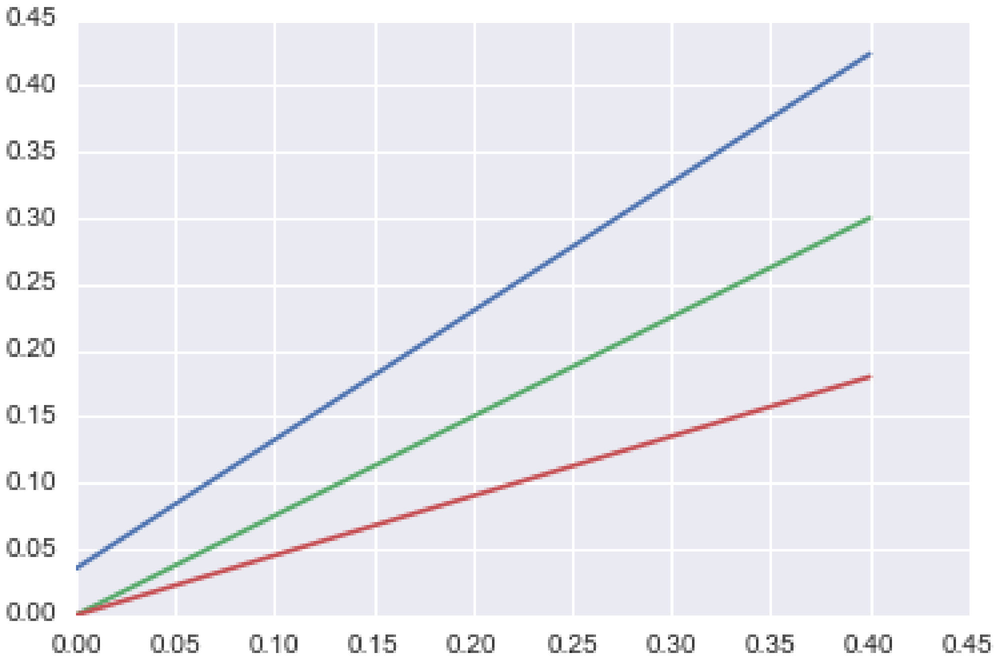
In [24]:
```
for Hor in HorizonCoefficients.index:
    HorizonCoefficients.ix[Hor,'SWC25'] = HorizonCoefficients.ix[Hor,'Inte
    HorizonCoefficients.ix[Hor,'Slope'] * 0.25
```

In [25]:
```
HorizonCoefficients
```

Out[25]:

Horizon	Slope	Intercept	LL	DUL	SWC25
Gravel	0.638859	-0.012200	0.004688	0.120	0.147515
SubSoil_0	0.971923	0.035146	0.092807	0.320	0.278127
TopSoil_0	0.950379	0.131111	0.172804	0.350	0.368705
TopSoil_30	0.886315	0.030407	0.139319	0.245	0.251986
TopSoil_50	0.487783	0.024764	0.078916	0.175	0.146709
SubSoil_30	0.750000	0.000000	0.064965	0.224	0.187500
SubSoil_50	0.550000	0.000000	0.046403	0.160	0.137500

```
In [59]: Hors = ['SubSoil_0','SubSoil_30','SubSoil_50']
         x=[0,0.4]
         for Hor in Hors:
             y=[]
             y.append(HorizonCoefficients.ix[Hor,'Intercept'] + HorizonCoefficients
             y.append(HorizonCoefficients.ix[Hor,'Intercept'] + HorizonCoefficients
             plt.plot(x,y)
```




```
In [26]: HorizonCoefficients.to_pickle('D:\GitHubRepos\StonySoilLysimeters\Calibrat

In [ ]: #!gist -p -d "Setting up CSC650 calibration for Export" CS650Calibration.ip

In [ ]: !gist -u https://gist.github.com/2b9d3cd05aefe707c181 CS650Calibration.ipyn
```