THE BENEFIT OF BOTTOM ASH IN THE MANUFACTURE OF CLAY FACE BRICK

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SAN FELIPE PLANT

- Built in 1985
- Residential face brick
- Production > 100 MMBE/year
- Wet preparation
- Soft extrusion
- Stick drying
- Dry set
- Dehacker


PLASTIC CHEW CLAY STOCKPILE

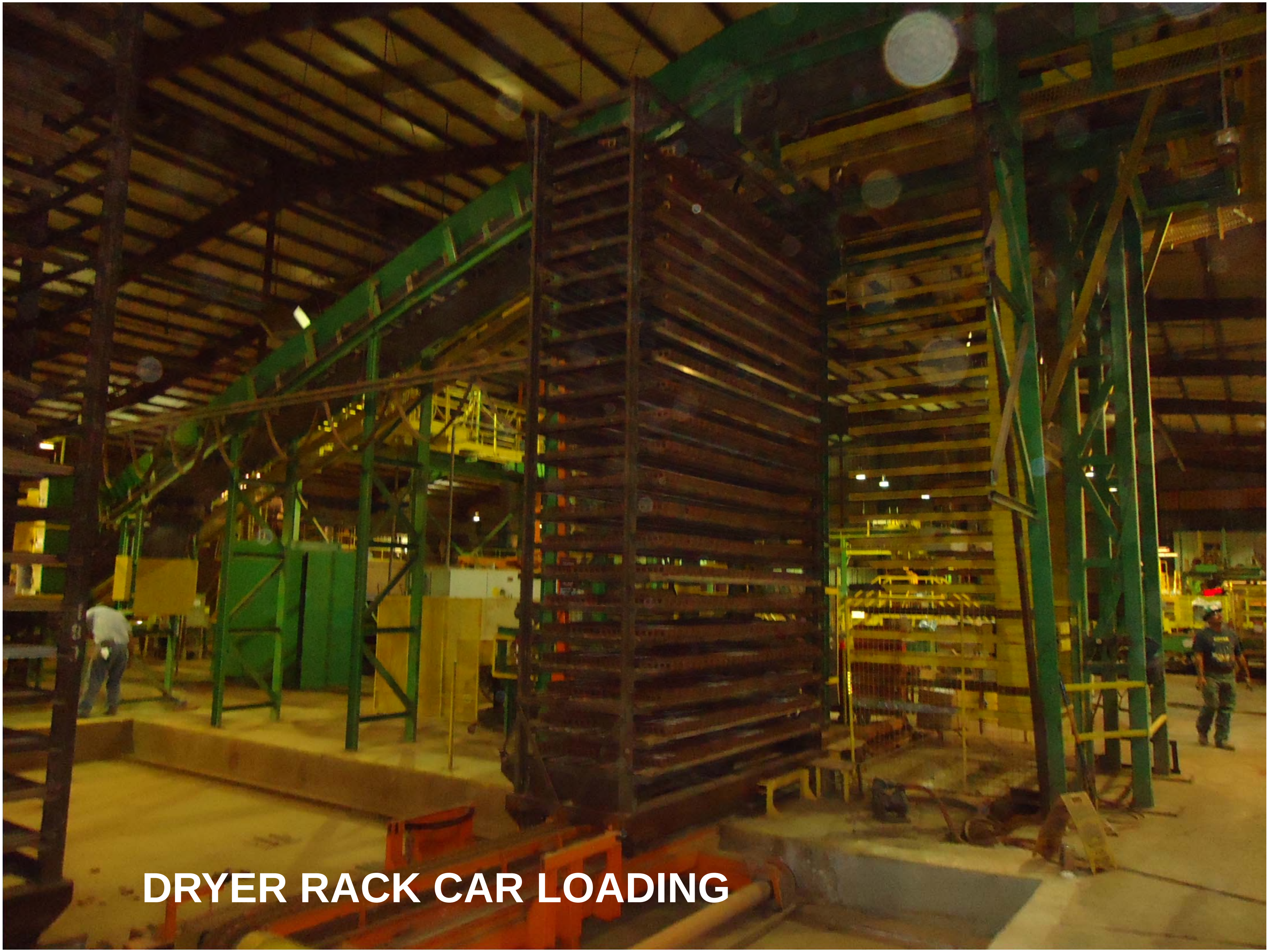

SANDY ABEL STOCKPILE

WET PREPARATION-ROTARY SCREEN FEEDER

MULTI-BUCKET RECLAIMER


OVERHEAD DOOR
SOFT EXTRUSION


MULTI-WIRE HARP CUTTER


DRYER RACK CAR LOADING


INDIVIDUAL "STICK" DRYING
SEMI-CONTINUOUS DRYER
3
5
2


24 WIDE KING SIZE DRY SET CAR


13
13
22 HIGH DRY SET


TOP-FIRED TUNNEL KILN


PELIGRO
DANGER
FALLING MATERIAL
AVISO
SOLAMENTE
PERSONAL
DANGER
PELIGRO

DEHACKER

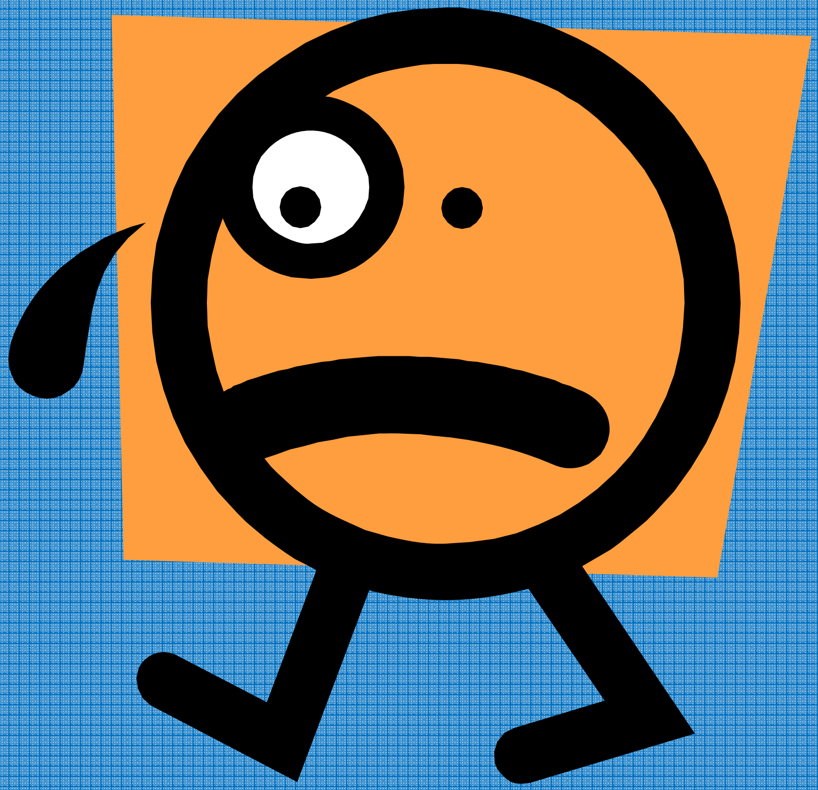

DEHACKER

PLANT STARTUP ISSUES IN 1985……

- Extrusion laminations
- Excessive dryer cracking
- Pre-heat cracking
- Cooling cracking
- Poor fired strength
- High bat loss (>50%)
- Poor quality
- Disastrous cost impact


PELIGRO
MATERIALES PUEDEN CAERSE
DANGER
FALLING MATERIAL
DANGER
THIS MACHINE STARTS AUTOMATICALLY
PELIGRO
ESTA MAQUINA ARRANCA AUTOMATICAMENTE
AVISO
SOLAMENTE PERSONAL
ONLY

AFTER MUCH RESEARCH, MANY TRIALS AND ERRORS……



IN 1987 A GROG PLANT WAS INSTALLED AND BOTTOM ASH WAS INTRODUCED

FAST FORWARD 25 YEARS

PURPOSE OF THE WORK

- To study the characteristics of the combined materials, with and without bottom ash.
- To determine the mechanisms at work which make the bottom ash effective.
- To understand the key process control parameters necessary for ongoing success.
- To provide scientific evidence of the benefits of bottom ash in the manufacture of clay face brick.

SFP test bodies

Non – bottom ash body (SFP-17)

Chew clay	50%
Abel sand	50%

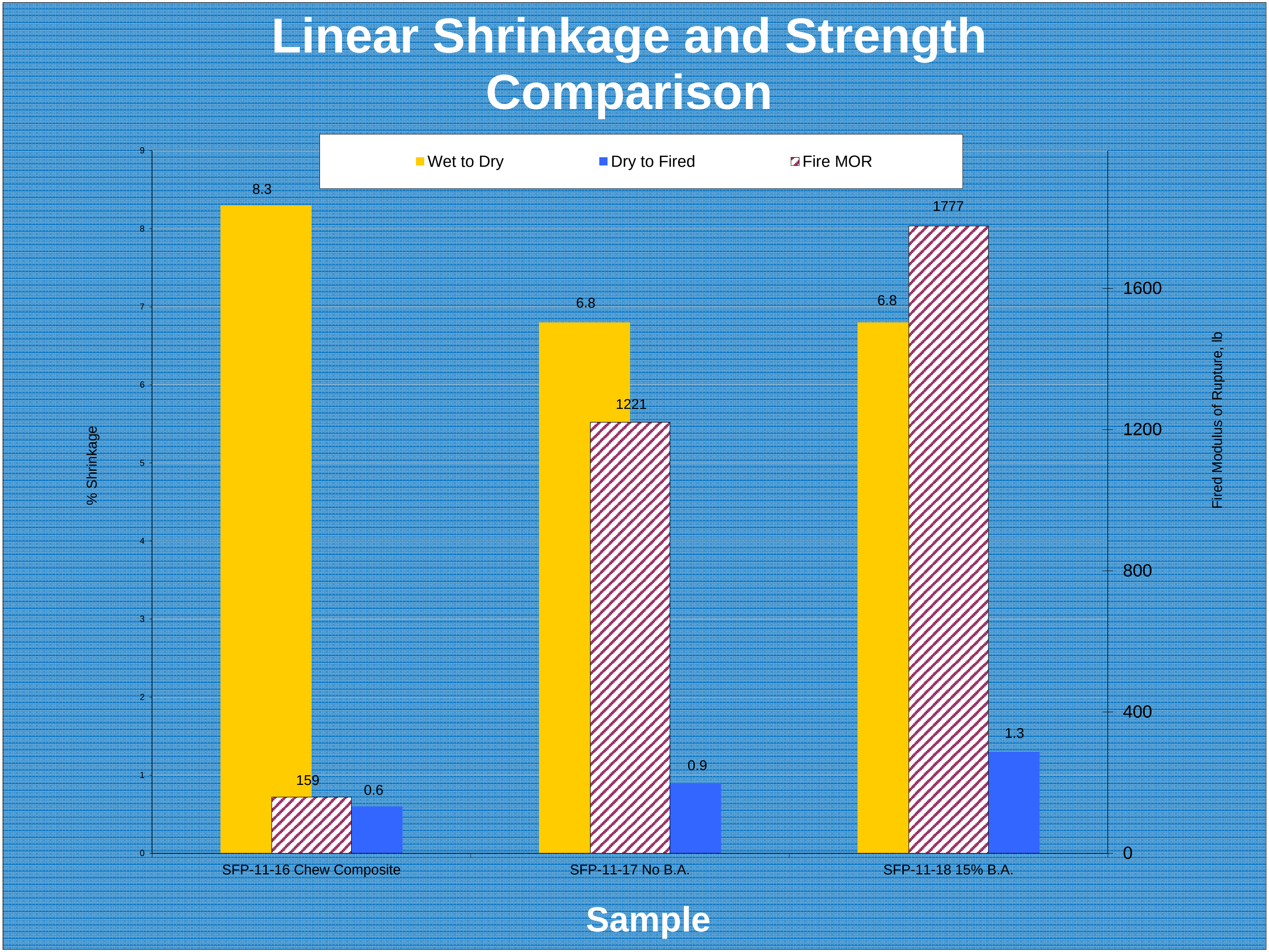
Current SFP bottom ash body (SFP-18)

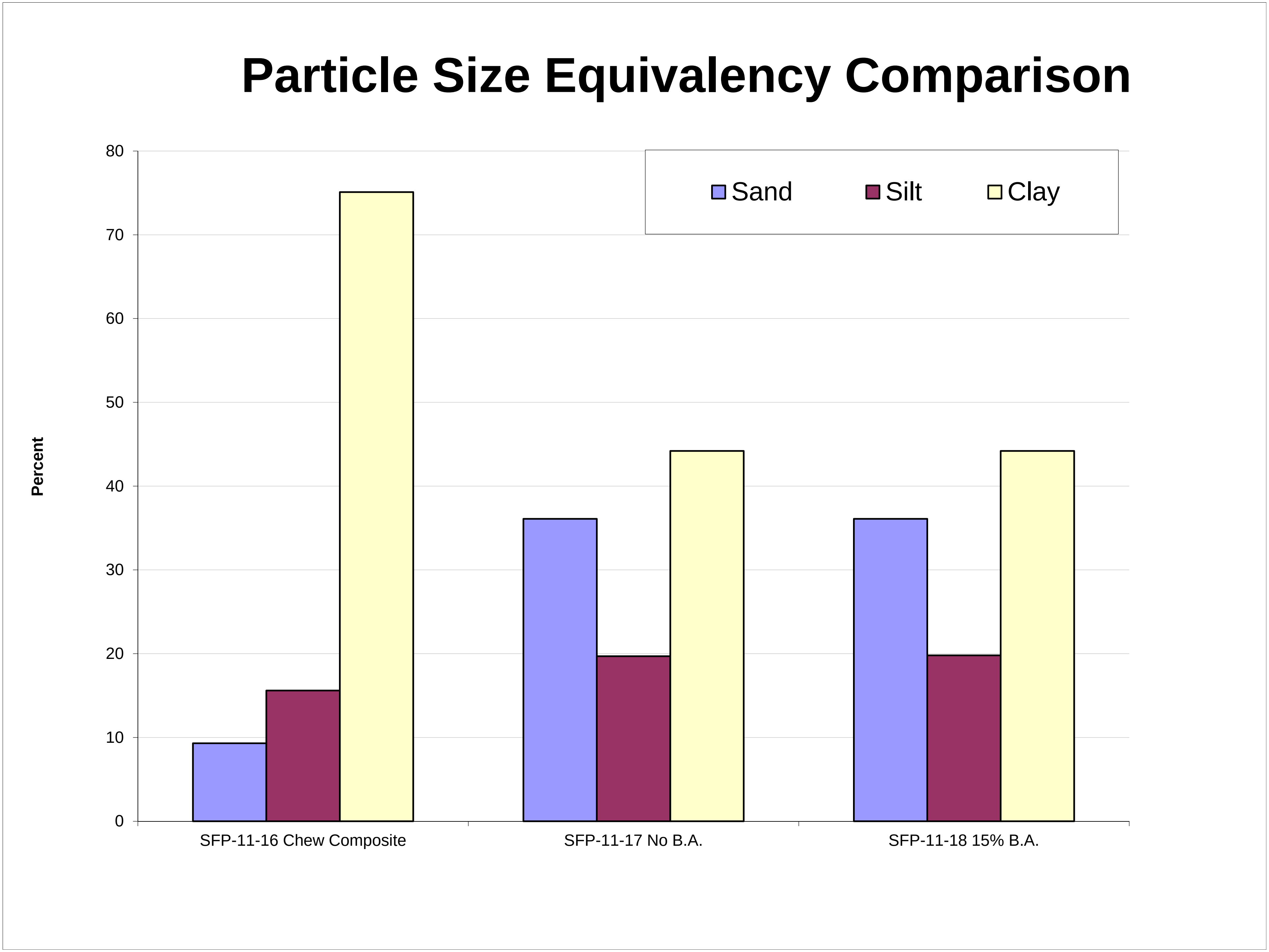
Chew clay	53%
Abel sand	32%
Bottom ash	15%

Analyses performed

- ❑Dry and fired physical properties
- ❑Particle Size Equivalent
- ❑Pore size distribution
- ❑Simultaneous Thermal Analysis
- ❑Chemical analysis
- ❑Mineralogy XRD
- ❑Microscopy

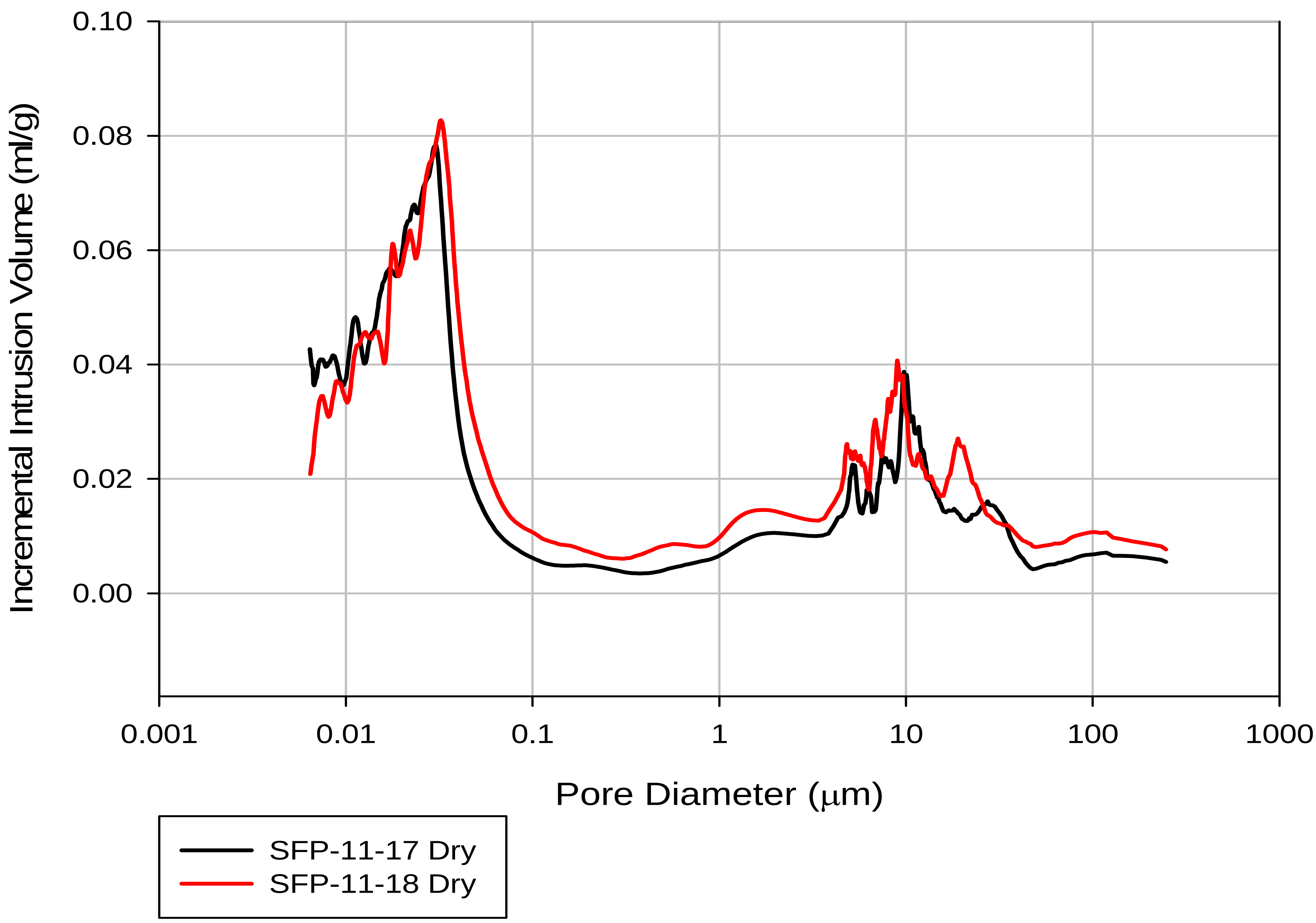
FINDINGS


Linear Shrinkage and Strength Comparison
Wet to Dry
Dry to Fired
Fire MOR
% Shrinkage
Fired Modulus of Rupture, lb
0
1
2
3
4
5
6
7
8
9
0
400
800
1200
1600
8.3
159
0.6
6.8
1221
0.9
6.8
1777
1.3
SFP-11-16 Chew Composite
SFP-11-17 No B.A.
SFP-11-18 15% B.A.
Sample

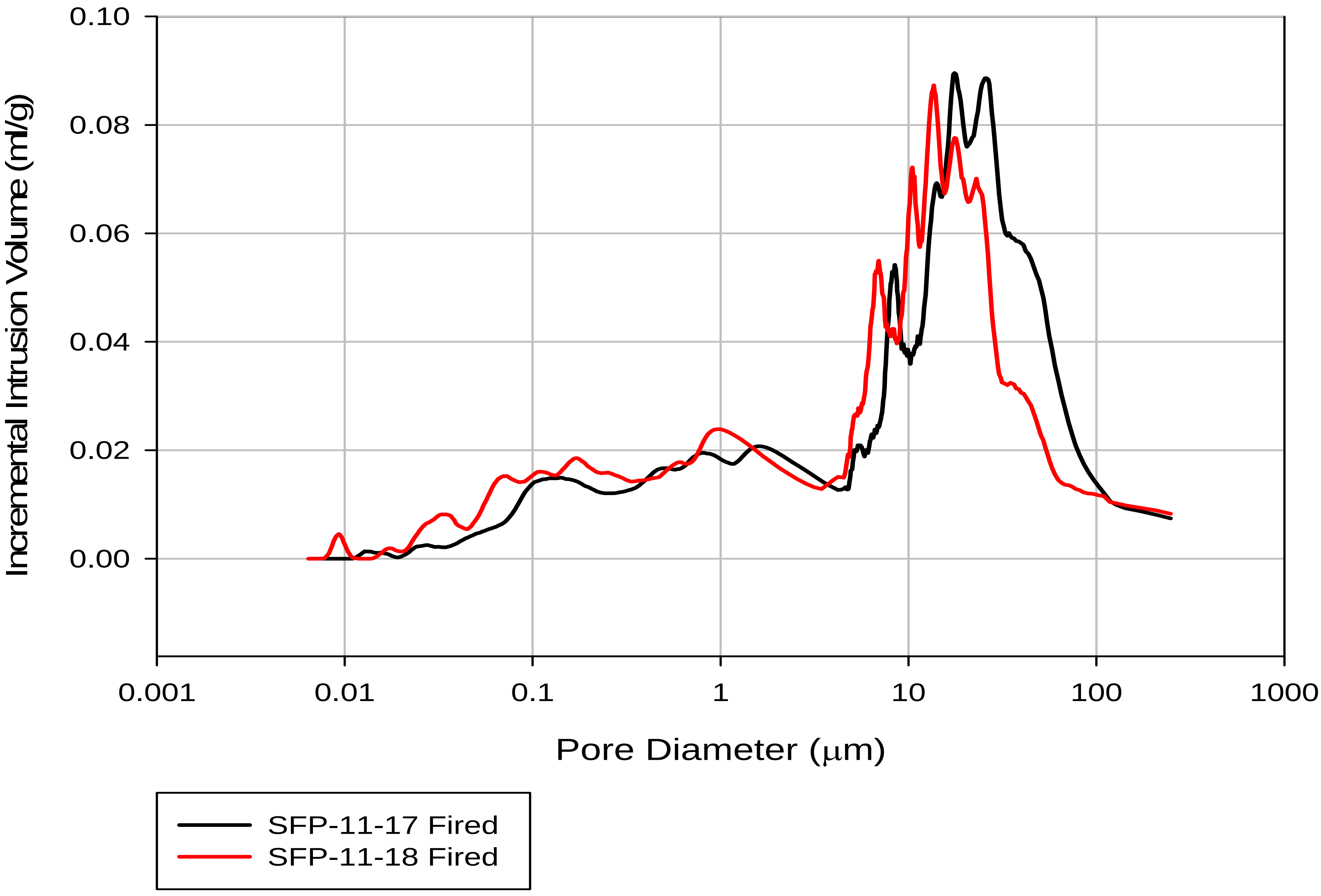


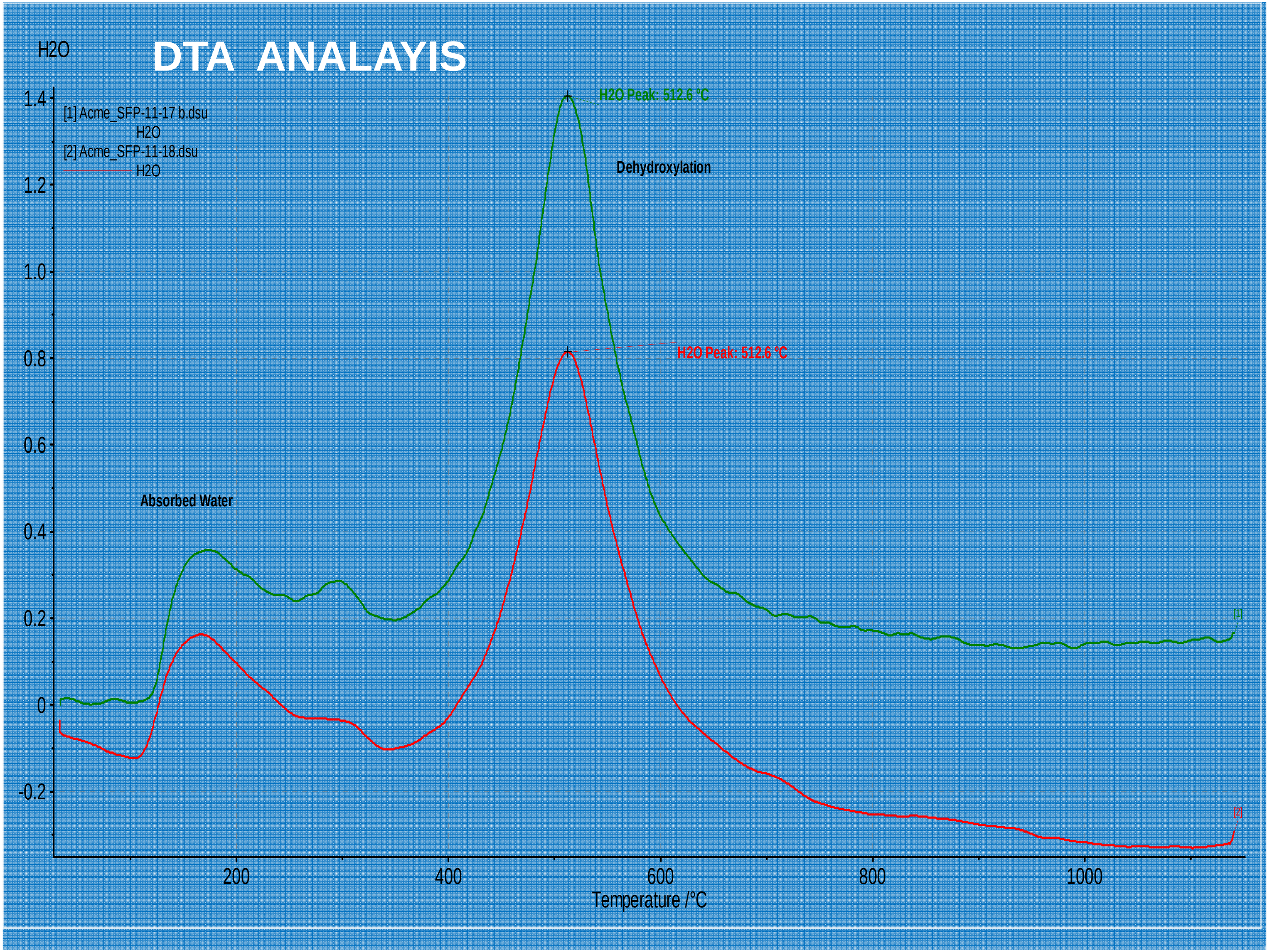
Particle Size Equivalency Comparison
Sand
Silt
Clay
Percent
0
10
20
30
40
50
60
70
80
SFP-11-16 Chew Composite
SFP-11-17 No B.A.
SFP-11-18 15% B.A.

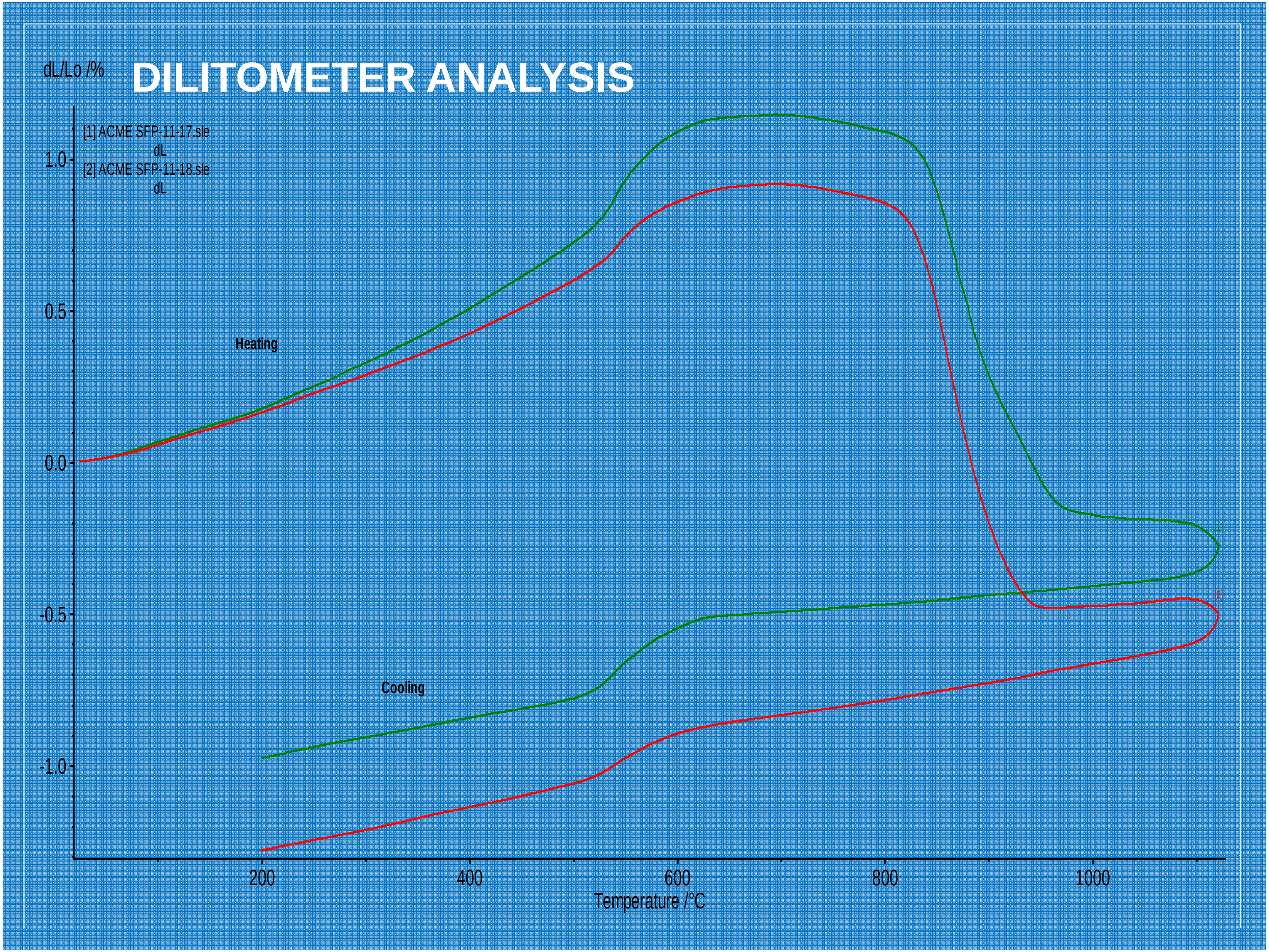
PORE SIZE DISTRIBUTION Dry Brick



PORE SIZE DISTRIBUTION Fired Brick




DTA ANALAYIS
H2O
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
-0.2
[1] Acme_SFP-11-17 b.dsu
H2O
[2] Acme_SFP-11-18.dsu
H2O
H2O Peak: 512.6 °C
Dehydroxylation
H2O Peak: 512.6 °C
Absorbed Water
[1]
[2]
200
400
600
800
1000
Temperature /°C


DILITOMETER ANALYSIS
dL/Lo /%
[1] ACME SFP-11-17.sle
dL
[2] ACME SFP-11-18.sle
dL
1.0
0.5
0.0
-0.5
-1.0
Heating
Cooling
[1]
[2]
200
400
600
800
1000
Temperature /°C

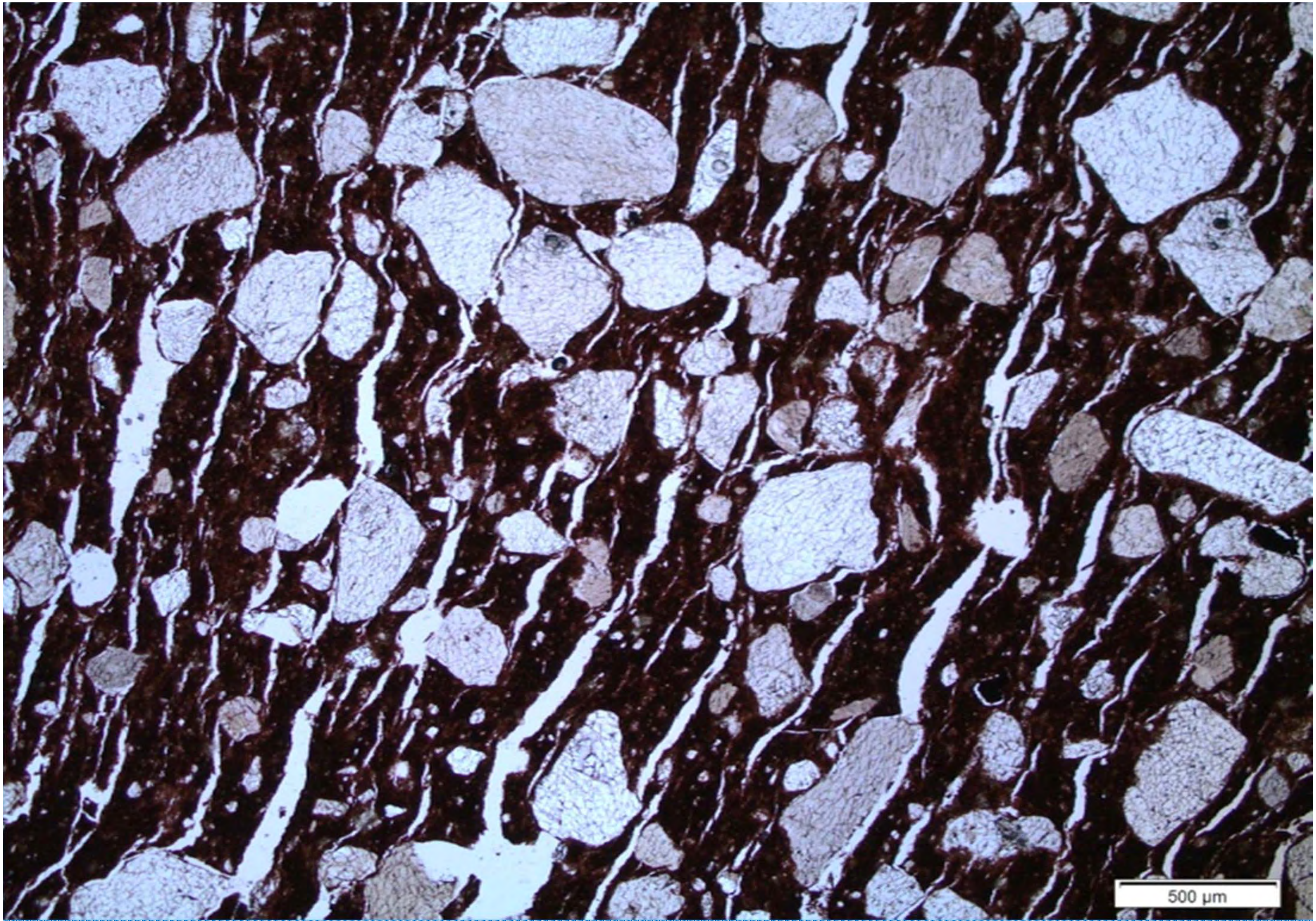
Approximate chemistry and mineralogy of the SFP body components.

Chemistry	Chew clay %	Abel sand %	Bottom ash %
SiO_2	46.1	83.7	42.8
Al_2O_3	15.6	13.0	16.8
Fe_2O_3	5.70	3.31	7.52
Na_2O	0.29	0.05	1.09
K_2O	2,24	0.26	0.38
CaO	10.9	0.05	22.0
MgO	3.08	0.25	4.27
TiO_2	0.66	0.32	1.29
S	<0.05	<0.05	0.34
Mineralogy			
Quartz	16	65	5
K-feldspar	5	-	<5
Plagioclase-fsp	-	-	10
Mica/illite	12	-	-
Smectite	42	-	-
Kaolinite	-	32	-
Calcite	17	-	-
Clinopyroxene	-	-	15
Gehlenite	-	-	20
“Amorphous”	-	-	<40

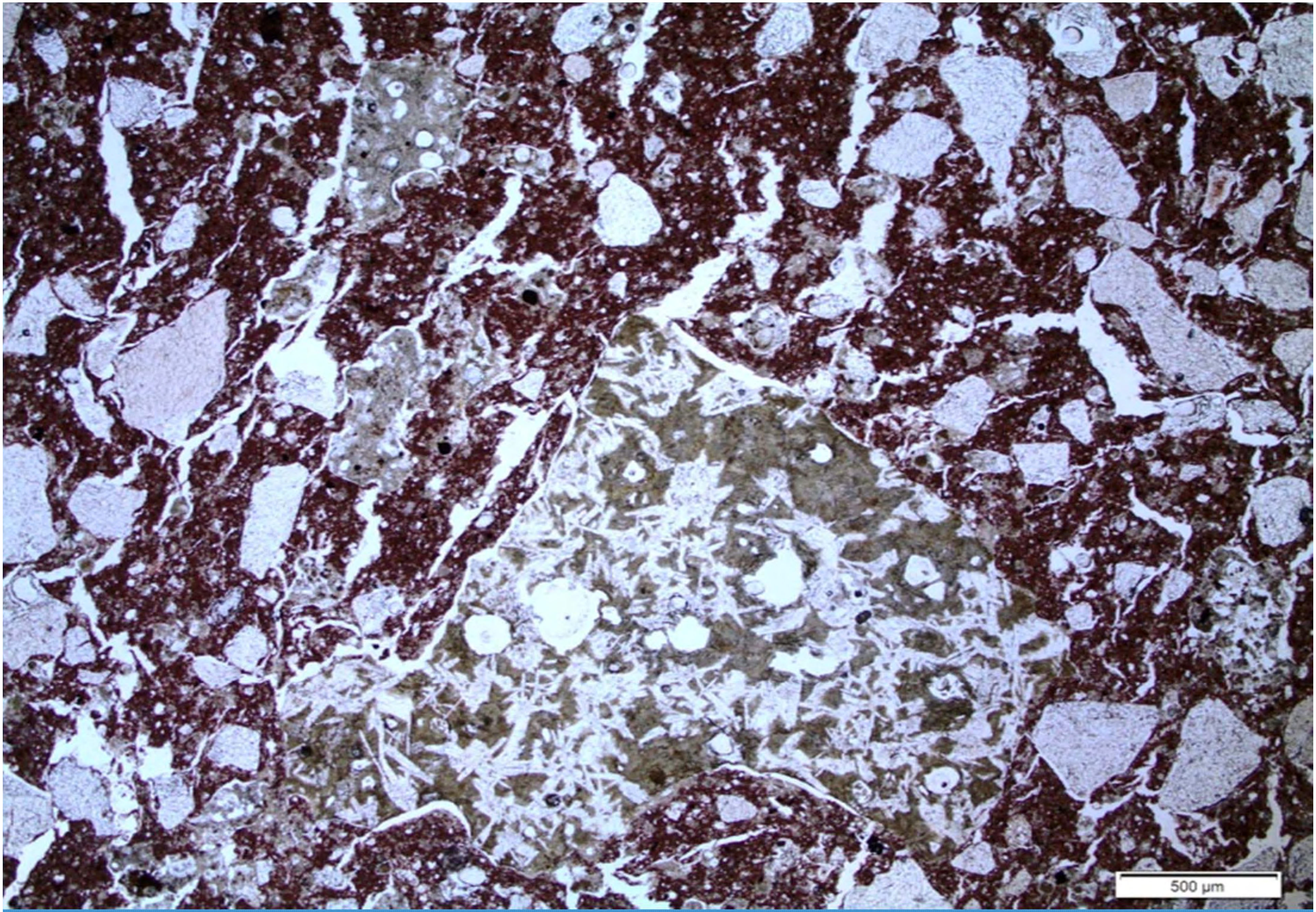
Comparison of chemical and mineralogical compositions : SFP17 and SFP18

Major chemistry	Approx unit	**SFP 17 no BA unfired**	**SFP 17 no BA fired**	**SFP 18 BA unfired**	**SFP 18 BA fired**
SiO_2	%	65.35	73.8	57.48	66.9
Al_2O_3	%	**13.33**	**11.9**	**14.10**	**13.0**
Fe_2O_3	%	4.64	4.77	5.42	5.82
Na_2O	%	0.26	0.29	0.33	0.43
K_2O	%	1.52	1.42	1.65	1.49
CaO	%	**6.86**	**6.34**	**10.13**	**9.86**
MgO	%	2.03	1.71	2.49	2.23
TiO_2	%	0.56	0.54	0.69	0.68
Mineralogy					
Quartz	%	**40.5**	**34**	**30**	**20**
Plagioclase	%	-	**30**	**5**	**35**
Clinopyroxene	%	-	-	-	**12**
Mica/illite	%	<5	-	<5	-
Hematite	%	-	<5	-	<5
Smectite	%	21	-	22	-
Calcite	%	11	-	12	-
Kaolinite	%	16	-	10	-
"Amorphous"	%	30	35	40	30

MIRCOSCOPIC ANALYSIS



NON BOTTOM ASH BODY



BOTTOM ASH BODY

SAN FELIPE PLANT TODAY

- > 100 MMBE per year
- Exciting range of Heritage KS Face Brick
- Excellent quality
- Effective QC controls
- < 2% Bat loss
- Highly profitable
- LEED credits
- EPA threat

ECONOMICS OF BOTTOM ASH

- Soluble salt content requires $BaCO_3$ usage
- Finer grinding needed to reduce “pyrite popping”
- Low cost body component
- Some energy benefit from autogenous combustion of carbon
- Energy reduction potential
- Process losses reduced
- LEED point advantage

CONCLUSIONS: Using Bottom Ash

- Reduces laminations
- Reduces drying shrinkage
- Reduces drying sensitivity
- Reduces dehydroxilation moisture
- Plagioclase feldspar phase increased
- Acts as an effective, stable flux
- Increases fired strength
- Reduces quartz inversion stresses
- Reduces process losses
- Non-hazardous body component

FINISHED PRODUCT QC

ADOBE WELLS WHITE #6 KING SIZE