

Prívíddargreining & berggreining
með „Petroscope 4D“ og tölfræðileg
spá um tæknieiginleika með
„Techmodel“ til eftirlits með gæðum
fylliefna

Steinsteypudagur 21. febrúar 2014

Porgeir S. Helgason

Petromodel ehf og Verkís hf

Inngangur

- Myndband
 - Frá Tækniháskólanum í Graz
 - Skrá: [Petroskop-H264 5Mbit 720p_fin.mp4](#)
- Sýnir Petroscope_4D í Austurríki
 - Lykilmælitæki í doktorsverkefni Holgers Bach (2013; á vefnum, sjá heimildaskrá aftast) um járnbrautamulning sem kostað var af járnbrautunum ÖBB
 - Framhaldsverkefni í bígerð
 - Einnig notað af jarðgangadeild ÖBB í framhaldsverkefni
 - Framhaldsverkefni með austurríska jarðgangaiðnaðinum í bígerð
 - Einnig meistaraverkefni í Austurríki
 - (Áður eru komnar tvær doktorsritgerðir um þróun Petroscope-tækninnar og ein meistararitgerð um Techmodel-hugbúnaðinn)



Inngangur

- Dr. Holger Bach er nú starfsmaður Petromodels með aðsetur í Austurríki
 - Verður með fyrirlestur um doktorsverkefnið og framhaldsrannsóknir í næstu Íslandsheimsókn
 - Holger er í þessum töluðum orðum að flytja fyrirlestur um áðurnefnd verkefni á þýskri jarðtækniráðstefnu
 - www.messen-in-der-geotechnik.de/
- Nýjasta verkefninu lauk í gær
 - Valgeir Flosason vinningshafi Steinsteypufélagsins hefur mælt efnin sem hann notar í meistarverkefni við HR og NMÍ
 - Heilsíð upp á Valgeir hér frammi í hléi og hann getur sýnt ykkur hráar niðurstöður en síðar munu við heyra hvað hann les út úr þessu varðandi tilraunasteypuna sem hann hefur unnið með
- Á undanförunum árum hafa verið unnin fjölmörg verkefni
 - Vegagerðin í New Hampshire, Jarðfræðistofnun Austurríkis o.fl.
 - Járnbrauta- og jarðgangaverkefni fyrir ÖBB eru þó langstærst og hafa sannað nothæfni Petroscoptsins fullkomlega

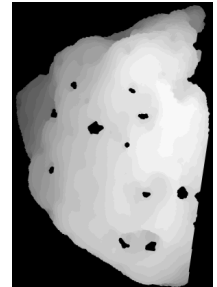
Petroscope 4D



3

Petroscope_3D_4/63: Stærð

- The measured and calculated $s=SIZE$ property and related sub-properties
 - Long, intermediate and short axis = L, I, S of the minimum bounding box/prism
 - Sieve size (simulation; ellipsoid)
 - Particle size distribution (cf. EN 933-1)
 - Volume of particle (= mass for constant density)



Petroscope 4D



4

Petroscope_3D_4/63: Lögun

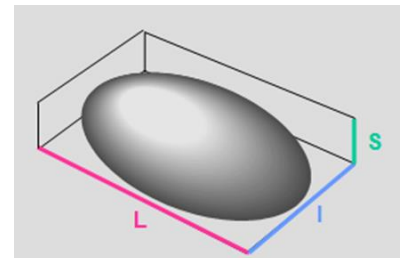
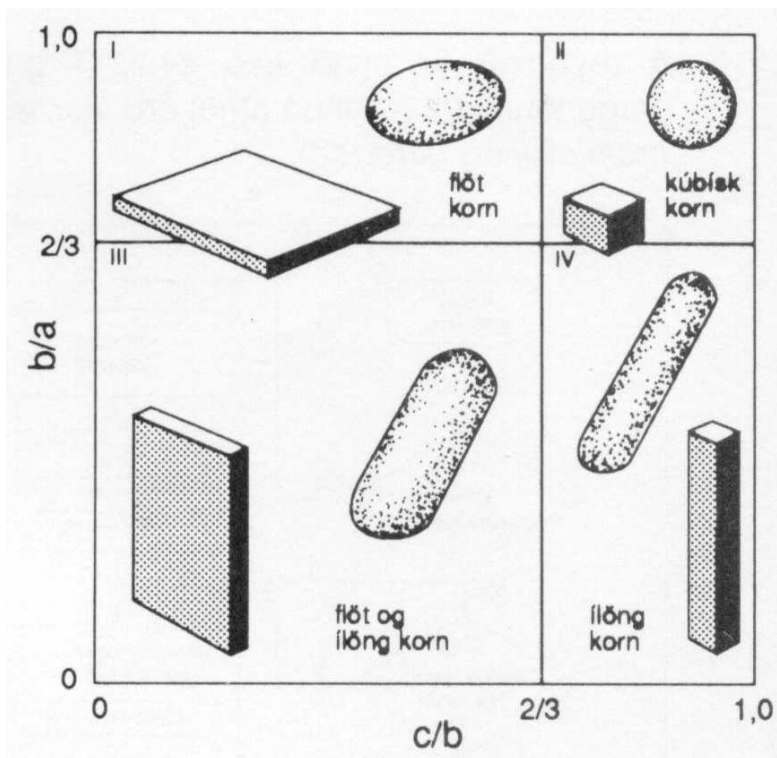
- The measured and calculated sh=SHAPE property and related sub-properties:
 - Sphericity ΨP
 - Flatness Ratio
 - Elongation Ratio
 - Zingg's form class:
 - Flat, cubical, flat & elongated, elongated
 - Shape Index (cf. EN 933-4)
 - Flakiness Index (cf. EN 933-3)
 - Surface area of upper hemisphere

Petroscope 4D



5

Lögun: Form



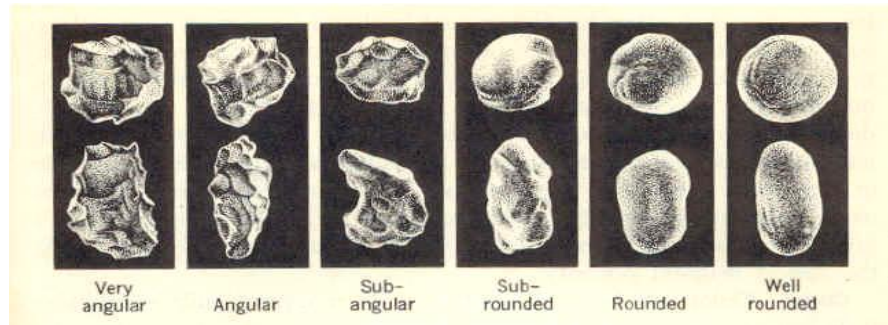
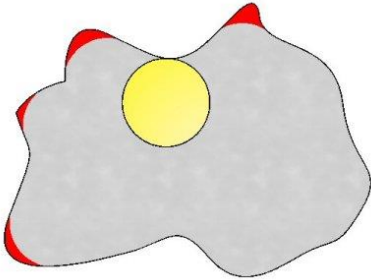
Petroscope 4D



6

Lögun: Ávali

- Volume of angles/corners
 - From Rolling-Ball mathematical method
- Powers' angularity class:
 - Very angular, angular, sub-angular, sub-rounded, rounded, well rounded



Petroscope 4D

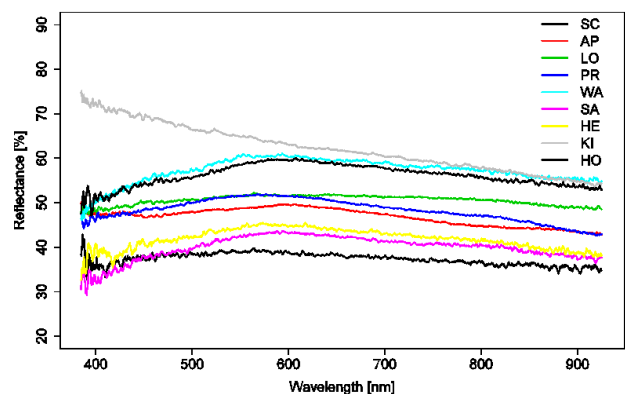


Petroscope_1D_4/63: Bergtegundir

- pc = petrographic composition
 - Rock type or variety
 - (Classification of recycled and secondary aggregates)
 - Classification algorithm by Dr. Vera Hofer (2011)



Petroscope 4D



And therefore the measuring instrument PETROSCOPE_4D = 3 geometrical + 1 compositional dimensions



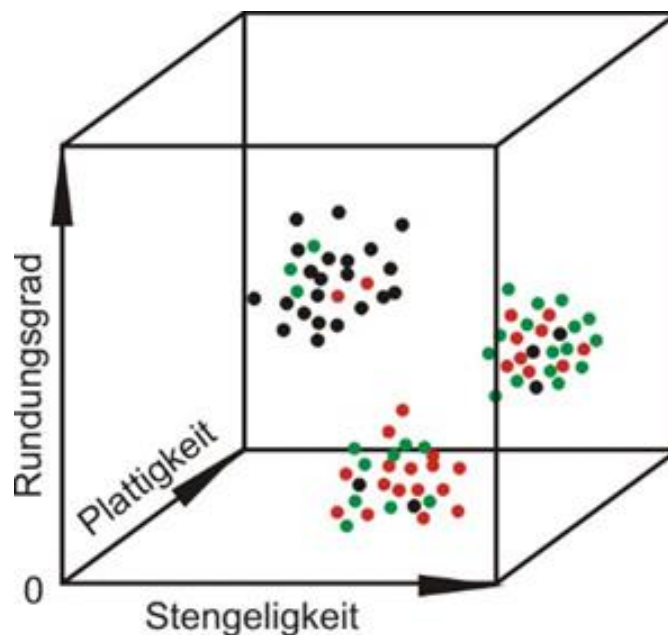
No testing equipment on the market today that I know of that measures all three fundamental properties - except for PetroScope



Worldwide patent rights granted and pending with a priority date from September 2004

Petroscope 4D

Prívíddar- og samsetningar- greining með Petroscopi



Petroscope 4D



A QUARRY IN N-IRELAND



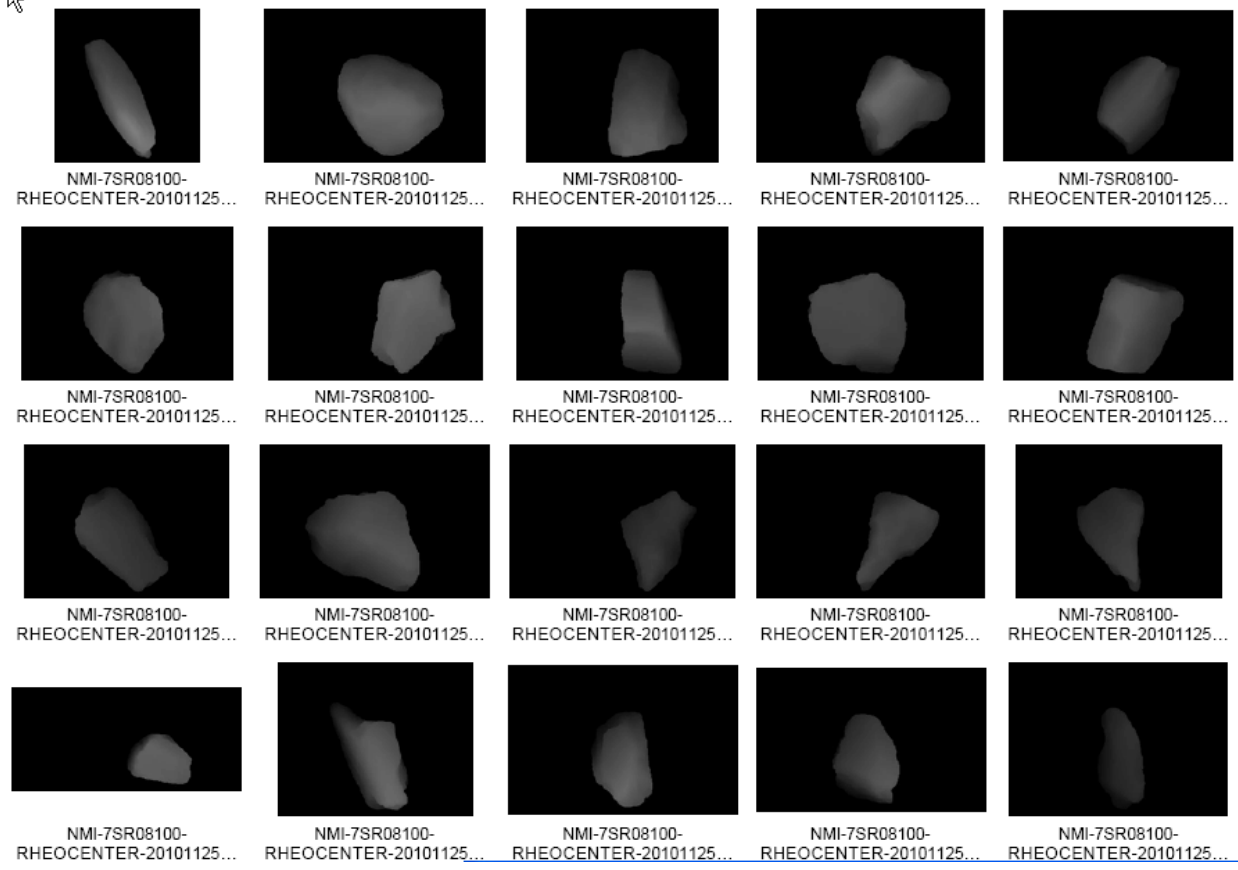
Petroscope 4D



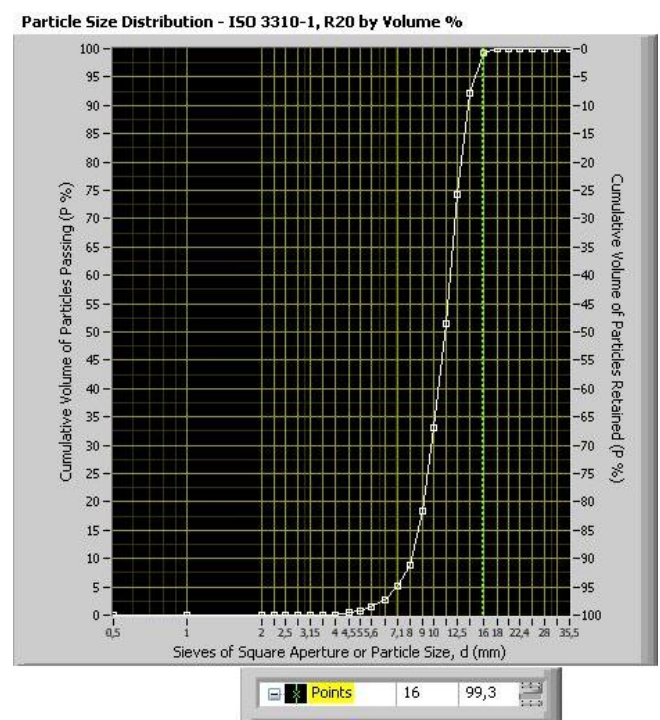
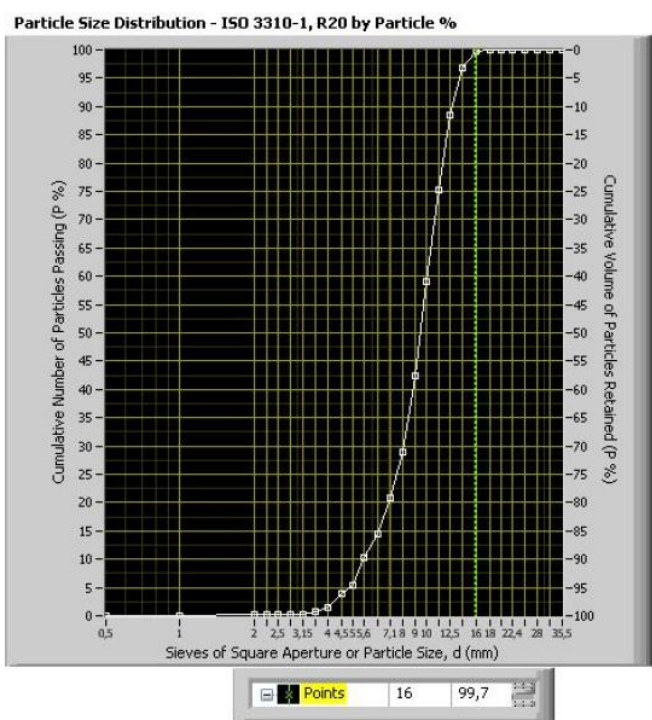
Particle No.	Image Quality	Long Axis mm	Med. Axis mm	Short Axis mm	Angle Vol.(%)	Min Sieve Size mm	Vol. mm3	Angularity	Form	Flatness	Elong.	Surface area mm2
1	Good	19,7	10,5	2,7	14,3	2122	Rounded	Flat	0,61	0,87	538,23	
2	Good	36,0	11,7	91,0	12,3	2615	Very Angular	Elongated	0,91	0,36	834,37	
3	Good	21,7	16,7	9,8	5,0	1804	Subangular	Flat	0,59	0,77	549,39	
4	Good	17,7	14,6	10,6	5,2	1362	Subangular	Cuboidal	0,72	0,82	424,54	
5	Good	17,1	12,1	7,6	3,8	879	Subrounded	Flat	0,63	0,71	329,62	
18	Good	16,3	10,4	10,3	4,0	932	Subrounded	Elongated	0,99	0,64	356,33	
19	Good	14,6	12,1	8,8	5,9	805	Subangular	Cuboidal	0,73	0,83	324,56	
20	Good	19,0	8,5	4,9	4,7	426	Subangular	Flat and Elong.	0,58	0,45	247,25	
21	Good	17,5	11,2	8,9	6,2	882	Angular	Elongated	0,79	0,64	361,41	
22	Good	16,8	13,3	9,0	4,4	1273	Subrounded	Cuboidal	0,68	0,79	444,03	
23	Dim. Impaired	19,5	14,0	9,1	8,9	1244	Very Angular	Flat	0,65	0,72	449,08	
24	Good	13,6	11,0	7,4	4,0	693	Subrounded	Cuboidal	0,67	0,81	257,90	
25	Good	8,5	6,8	2,9	7,7	109	Very Angular	Flat	0,42	0,80	88,32	
26	Good	18,2	11,3	9,2	8,4	908	Very Angular	Elongated	0,81	0,62	372,38	
27	Good	12,8	8,8	4,0	5,4	6,8	251	Subangular	Flat	0,45	0,69	162,56
400	Good	28,4	8,8	5,8	8,4	7,5	770	Very Angular	Flat and Elong.	0,66	0,31	428,68
401	Good	16,6	12,6	12,2	9,4	12,4	1074	Very Angular	Cuboidal	0,97	0,76	369,04
402	Good	19,9	19,8	11,2	5,6	16,1	2203	Subangular	Flat	0,56	0,99	617,66
403	Good	19,2	11,7	8,0	17,8	10,0	867	Very Angular	Elongated	0,69	0,61	378,33
404	Good	23,6	10,1	6,6	5,6	8,5	916	Subangular	Flat and Elong.	0,65	0,43	409,71
405	Good	19,6	17,1	11,0	5,1	14,4	1831	Subangular	Flat	0,64	0,87	552,02
406	Good	19,7	10,5	7,0	24,2	8,9	635	Very Angular	Flat and Elong.	0,66	0,53	330,24
407	Good	22,0	15,1	10,2	4,3	12,9	2054	Subrounded	Cuboidal	0,68	0,69	584,42
408	Good	19,4	13,5	6,8	10,4	10,7	752	Very Angular	Flat	0,50	0,70	317,83

Petroscope 4D





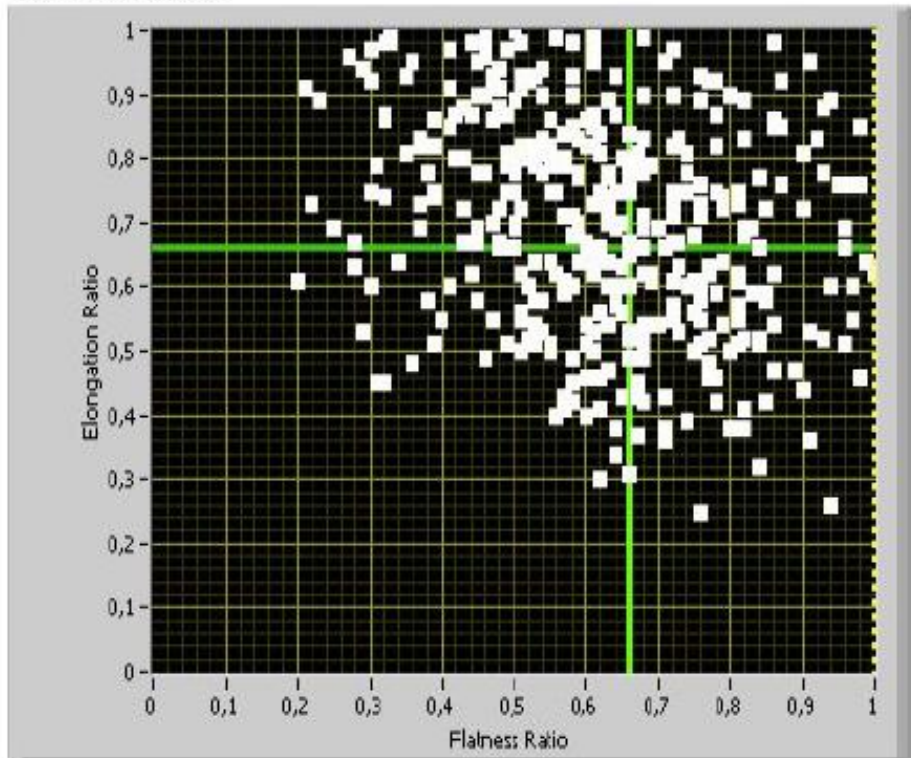
Petroscope 4D



Petroscope 4D



Form Ratio (Zingg)



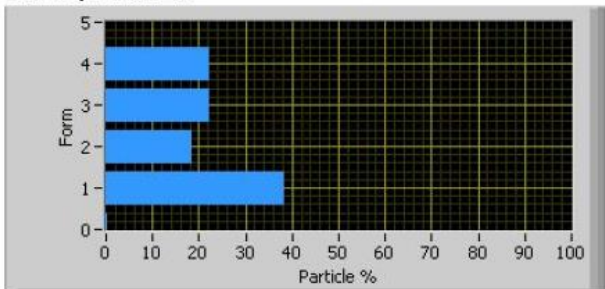
Sphericity: 0,66

Total No.: 381

Petroscope 4D



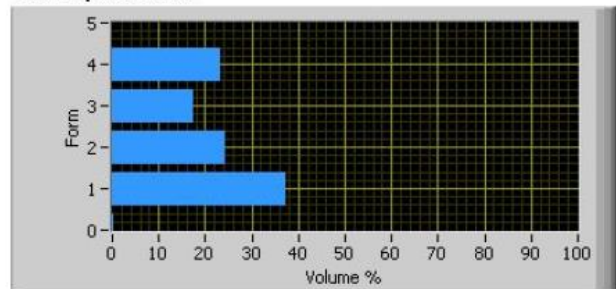
Form by Particle %



Total No.: 381

Flat - 1	Cuboidal - 2	Flat and Elong. - 3	Elongated - 4
37,8	17,6	22,3	22,3

Form by Volume %



Total Vol.: 295586

Flat - 1	Cuboidal - 2	Flat and Elong. - 3	Elongated - 4
36,6	23,6	17,2	22,6

Petroscope 4D



FLAKINESS INDEX REPORT

Testing Equipment: PETROSCOPE

Test ID: NMI-7SR08100-RHEOCENTER-20101125-MIK-Crozier
NMI

Test Start Date: 25.11.2010 14:38

Lab. Sample No.: Crozier14

Subsample No.: 01

Test Directory Location: C:\PetroScope-Data-FRUMSKRAR\7SR0

Flakiness Index: 11

SHAPE INDEX REPORT

Testing Equipment: PETROSCOPE

Test ID: NMI-7SR08100-RHEOCENTER-20101125-MIK-Crozier
NMI

Test Start Date: 25.11.2010 14:38

Lab. Sample No.: Crozier14

Subsample No.: 01

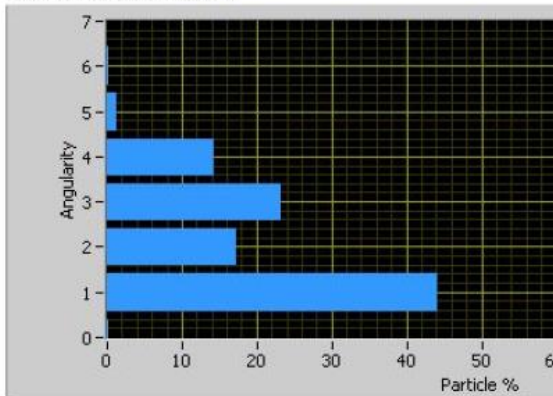
Test Directory Location: C:\PetroScope-Data-FRUMSKRAR\7SR0

Shape Index: 18

Petroscope 4D



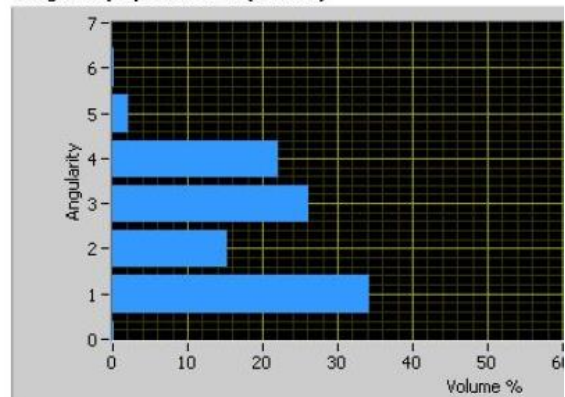
Angularity by Particle %



Total No.: 381

Very Angular - 1	Angular - 2	Subangular - 3	Subrounded - 4	Round - 5	Well-rounded - 6
44,4	17,3	22,8	14,4	1,0	0,0

Angularity by Volume % (Powers)



Total Vol.: 295586

Very Angular - 1	Angular - 2	Subangular - 3	Subrounded - 4	Round - 5	Well-rounded - 6
34,3	15,4	26,2	22,5	1,7	0,0

Petroscope 4D





NorStone Årdal

Operational Manager	Svein Mæland
Address	NO-4137 Årdal i Ryfylke, Norway
Phone	+47 51 75 42 00
Fax	+47 51 75 42 01
Shipping capacity	8,000 tdw
Rock type	<ul style="list-style-type: none"> ■ Gneiss/granite ■ Deposits in moraine and from river

Products	<ul style="list-style-type: none"> ■ Aggregates for asphalt and concrete ■ Bridges ■ Concrete platforms for oil and gas industry ■ Ready-mix concrete
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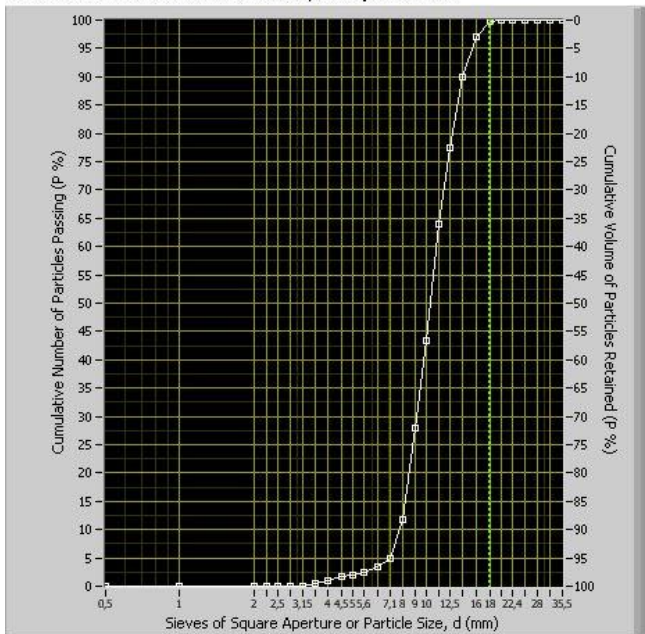
aggregate from Årdal is norwegian reference aggregate.

Products can be blended according to customer specification.

Petroscope 4D

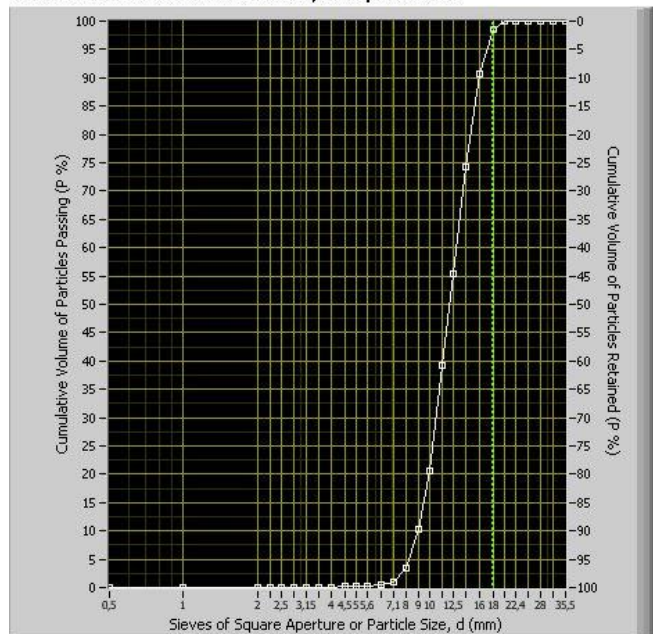


Particle Size Distribution - ISO 3310-1, R20 by Particle %



Points 18 99,6

Particle Size Distribution - ISO 3310-1, R20 by Volume %

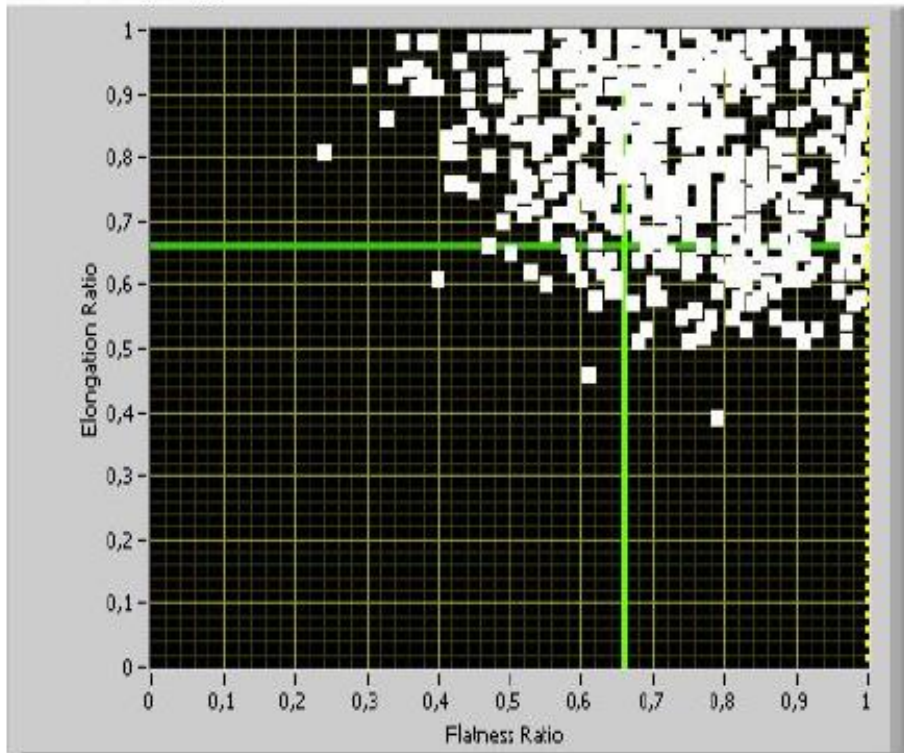


Points 18 98,6

Petroscope 4D



Form Ratio (Zingg)



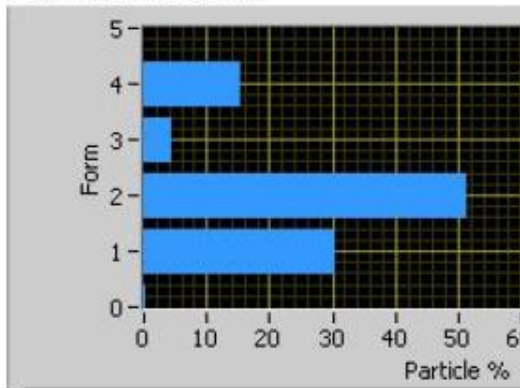
Sphericity: 0,76

Total No.: 557

Petroscope 4D



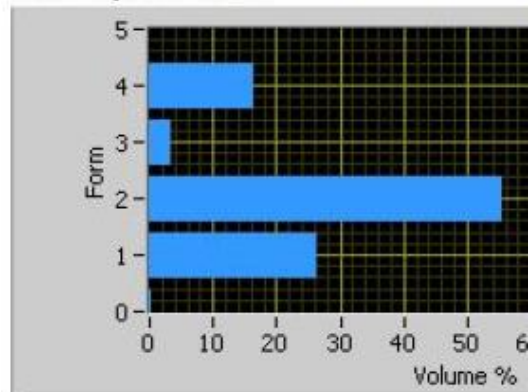
Form by Particle %



Total No.: 557

Flat - 1	Cuboidal - 2	Flat and Elong. - 3	Elongated - 4
29,8	51,0	4,3	14,9

Form by Volume %



Total Vol.: 580415

Flat - 1	Cuboidal - 2	Flat and Elong. - 3	Elongated - 4
25,6	54,7	3,3	16,4

Petroscope 4D



FLAKINESS INDEX REPORT

Testing Equipment: PETROSCOPE

Test ID: NMI-7SR08100-RHEOCENTER-20101207-ThSH-Norstc
NMI

Test Start Date: 7.12.2010 15:35

Lab. Sample No.: Norstone

Subsample No.: Aardal01

Test Directory Location: C:\PetroScope-Data-FRUMSKRAR\7SR0

Flakiness Index: 4

SHAPE INDEX REPORT

Testing Equipment: PETROSCOPE

Test ID: NMI-7SR08100-RHEOCENTER-20101207-ThSH-Norstc
NMI

Test Start Date: 7.12.2010 15:35

Lab. Sample No.: Norstone

Subsample No.: Aardal01

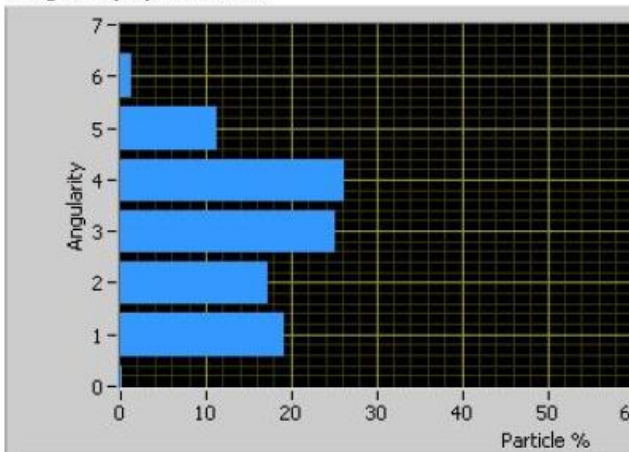
Test Directory Location: C:\PetroScope-Data-FRUMSKRAR\7SR0

Shape Index: 2

Petroscope 4D



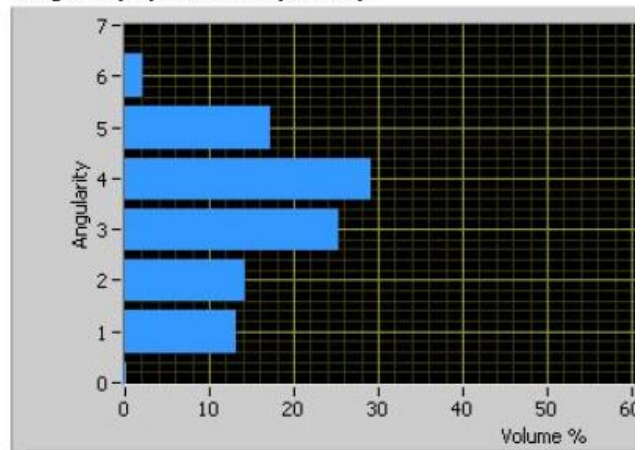
Angularity by Particle %



Total No.: 557

Very Angular - 1	Angular - 2	Subangular - 3	Subrounded - 4	Rounded - 5	Well-rounded - 6
19,2	17,2	25,1	26,4	11,3	0,7

Angularity by Volume % (Powers)



Total Vol.: 580415

Very Angular - 1	Angular - 2	Subangular - 3	Subrounded - 4	Rounded - 5	Well-rounded - 6
13,2	14,3	24,5	29,4	17,1	1,5

Petroscope 4D



The basic idea behind

Petromodel's products:

- The engineering or technical properties are governed by or based on some fundamental properties
- $EP = f [FP] = f [s, sh, pc]$
- Therefore
 - Petroscope - for measuring the FP
 - Techmodel - statistical software to model the f and predict the EP

Petroscope 4D



Tölfræðispá um tæknilega eiginleika

Petroscope 4D



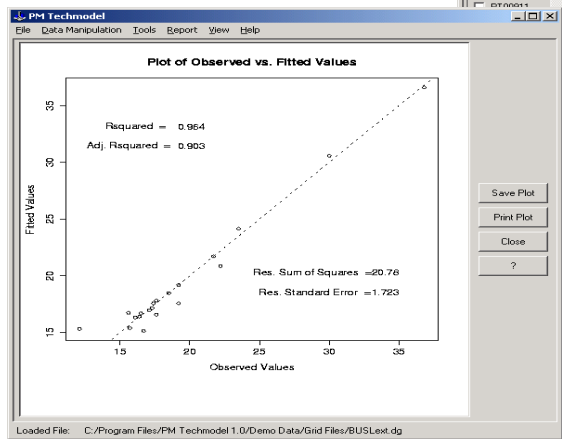
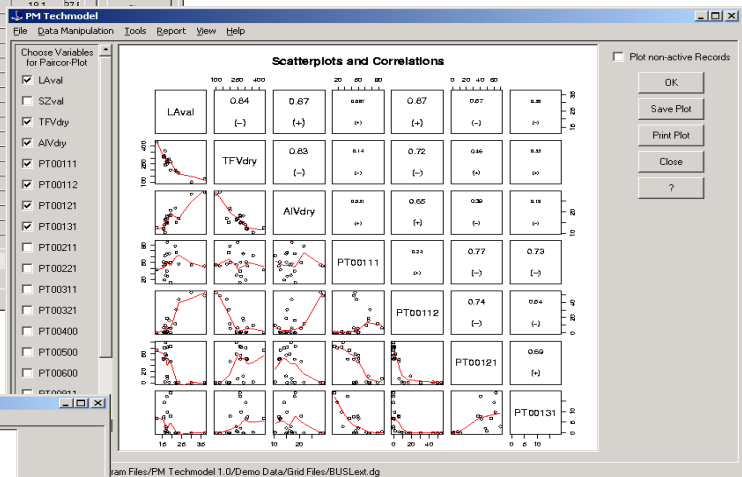
TECHMODEL

- For statistical or virtual testing of various engineering properties of aggregates.
- Version 1 in 2002 and version 2 in 2007
 - Developed with Petromodel by Uni. Klagenfurt
 - O.Univ.-Prof. Dr. Jürgen Pilz
- New version planned
 - Based on work for Dr. Holger's Bach thesis
 - By Dr. Vera Hofer of Uni. Graz

Petroscope 4D



Non-act	ID	SOURCE	LÁval	SZval	Bgstand	Bgmed	TFVdy	TPVwt	AIVdy	AIVwt	ISC
<input type="checkbox"/>	1	Bakkasel	16.5	19.9	3	8.4	242	176	16.2	18.2	36
<input type="checkbox"/>	2	Björgun_Akurey	16.4	15.1	0.9	4.8	369	238	10.5	13.1	93
<input type="checkbox"/>	3	Brúnaletta	17.1	17.4	2.1	8.5	270	199	14.9	16	95
<input type="checkbox"/>	4	Gleisá	17.3	20.1	2.1	8.5	269	174	18.1		
<input type="checkbox"/>	5	Haukadalsá	19.2	17.5	2	6.9	199	191	20.7		
<input type="checkbox"/>	6	Hjúnemel	17.6	18	2.2	6.4	275	195	15.2		
<input type="checkbox"/>	7	Hólabrú	15.7	16.7	1.4	6.4	319	212	12		
<input type="checkbox"/>	8	Hólmkelsá	21.7	20.6	1.7	7.8	197	179	21.8		
<input type="checkbox"/>	9	Hraunadó	15.6	17.2	1.9	6.8	311	211	12.3		
<input type="checkbox"/>	10	Jökulsá_á_Dal	17.6	19	2.1	6.6	251	198	17		
<input type="checkbox"/>	11	Jökulsá_á_Fjöllum	22.2	19.8	2	8.3	188	188	15.2		
<input type="checkbox"/>	12	Krossanes	16.7	22.6	2.9	10.1	242	194	16.7		
<input type="checkbox"/>	13	Lákkot	16.1	16.6	2.8	6.3	307	185	14		
<input type="checkbox"/>	14	Leitjarbotnar	30	25.1	4.4	13.4	100	101	28.3		
<input type="checkbox"/>	15	Makiarfjell	18.5	18.3	1.5	8.4	291	252	18.2		
<input type="checkbox"/>	16	Nordfjarkelsá	19.2	19.2	2.7	8.2	266	172	18.4		
<input type="checkbox"/>	17	Rauðanekur	23.5	20	2.3	9	175	137	17		
<input type="checkbox"/>	18	StoraFellssól	12.1	16.5	1.5	4.3	432	227	12.6		
<input type="checkbox"/>	19	Valhök	17.4	17.5	1.5	5.8	289	251	14.8		
<input type="checkbox"/>	20	Vatnsskáð	36.8	28	4.6	14.1	126	83	23.2		

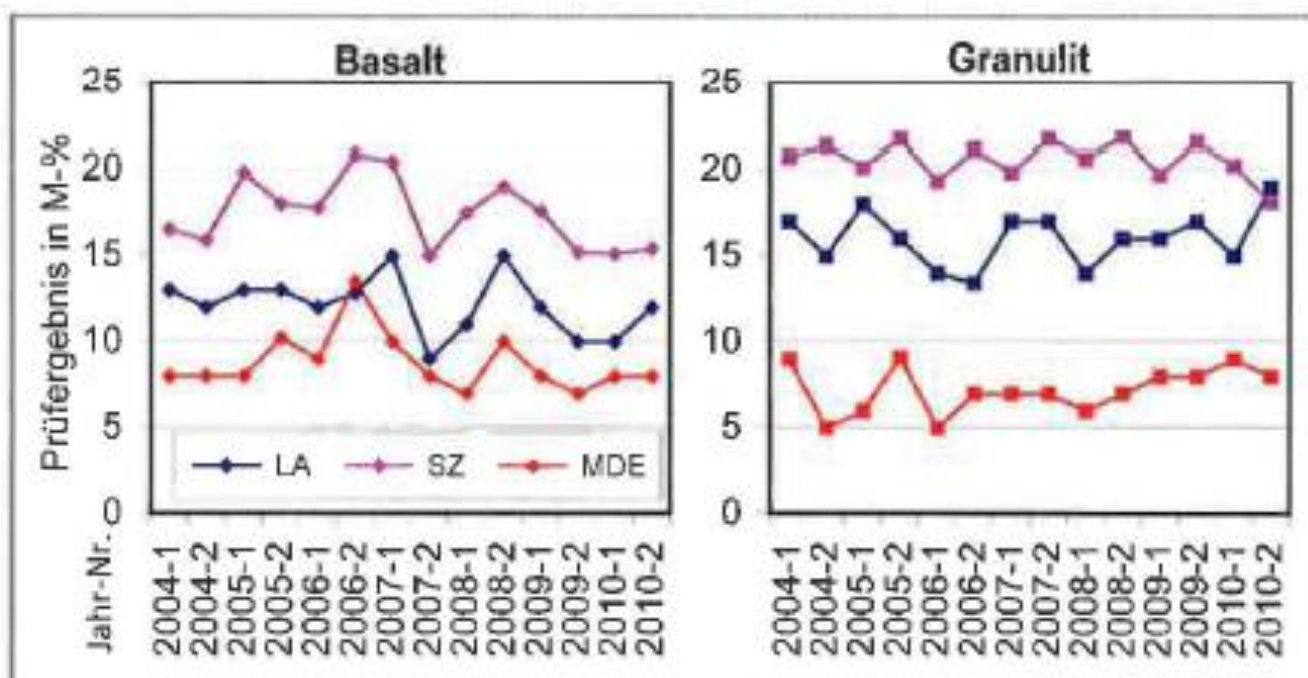


Eftirlit með framleiðslu fylliefna og annarra steinefna

Petroscope 4D



29



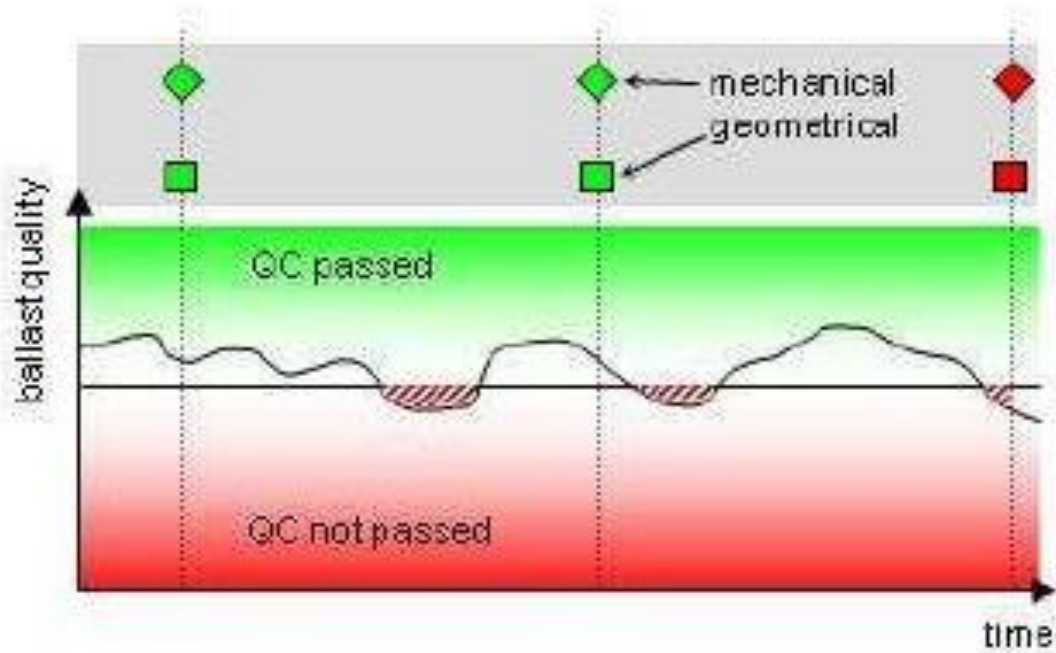
Prennskonar niðurbrotseiginleikar járnbrauta-mulnings í tveimur námum í Austurríki mældir tvisvar á ári 2004-2010

Bach, Kuttelwascher og Latal (2012)

Petroscope 4D



30



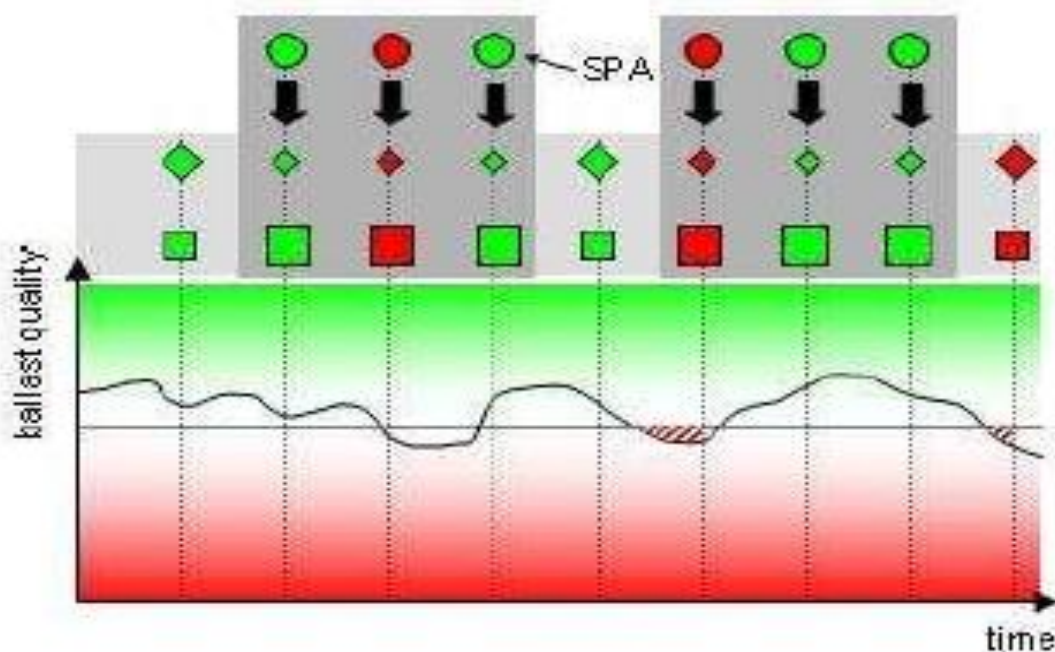
Hefðbundið eftirlit: Eðlisrænrir og rúmfræðilegir eiginleikar járnbrautamulnings mældir tvisvar á ári

Vera Hofer og Holger Bach – handrit (2012)

Petroscope 4D



31



Tölfræðilegt eftirlit með Petroscope og spáhugbúnaði (Techmodeli) til viðbótar við hefðbundið eftirlit

Hofer og Bach – handrit (2012)

Petroscope 4D



32

Heimildir

- Bach, Kuttelwascher og Latal 2012
 - Alternative Prüfverfahren zur qualitäts-sicherung von Gleisschotter / Alternative testing methods for quality control of railway ballast
 - » ZEVrail 136 (2012) 3 März
- Holger Bach 2013
 - Evaluation of attrition tests for railway ballast
 - » http://portal.tugraz.at/portal/page/portal/Files/i2110/docs/Abschlussarbeiten/Dissertation_Holger_Bach_Evaluation_of_attrition_tests.pdf
- Vera Hofer 2011
 - Functional Methods for Classification of Different Petrographic Varieties by Means of Reflectance Spectra
 - <http://link.springer.com/article/10.1007/s11004-011-9317-x>
- Vera Hofer og Holger Bach – handrit 2012
 - Statistical monitoring for continuous quality control of railway ballast
 - Lagt fram til birtingar í European Journal of Operational Research.

Petroscope 4D



33

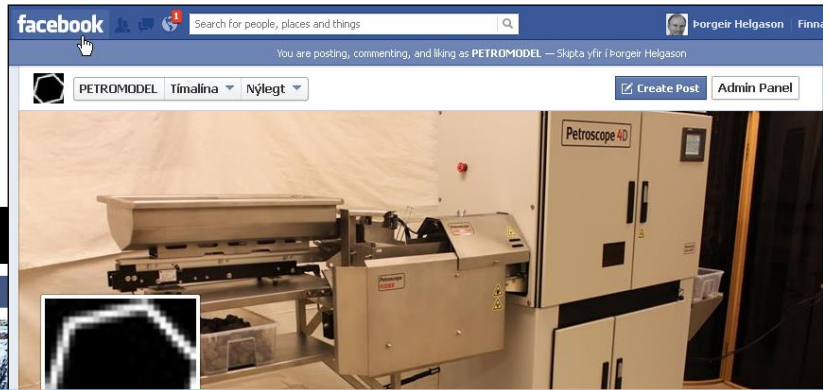
Petromodel

- Petromodel ehf
- Ofanleiti 2, Reykjavik
 - Porgeir S. Helgason
 - sími 864 4764
 - thorgeir@petromodel.is
 - www.petromodel.is

Petroscope 4D



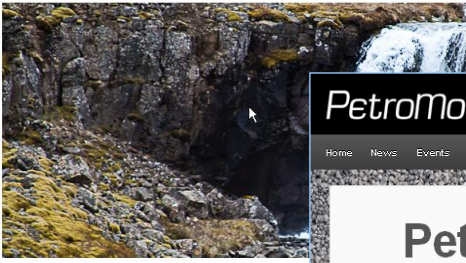
Facebook:
Petromodel



www.petromodel.is

PetroModel

SCIENCE PETROSCOPE 4D TECHMODEL



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Emails:

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Petroscope 4D

Measuring Equipment

Using machine vision, spectroscopy, advanced mathematics and statistics for measuring fundamental properties of rocks. Click the video on the right to see more.

[Read More !](#)



Petromodel Petroscope 002

0:00 / 0:58 YouTube


Recent News

- Chinese patent granted February 17, 2014
- Dr. Holger Bach of Petromodel eht talking at Messen in der Concrete 2014 in

Upcoming Events

[Petroscope_4D shown at Icelandic Concrete Day 2014](#)

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