



Comparison of Terra with other XRDs

Compared to current XRD instruments:

- ✓ 10 - 100 times lighter
- ✓ 10 - 100 times smaller
- ✓ 10 - 100 times less power
- ✓ 1/2 - 1/5 acquisition cost

80kg Rigaku Miniflex (not pictured 1kW generator and water circulator).



inXitu Terra
15kg, all included
Similar performance

The CheMin mineralogical instrument on
MSL and the field portable Terra
instrument available for NAI field
campaigns



Small inset text: Mars Science Laboratory



1
00:00:07,760 --> 00:00:04,610
good morning or afternoon everyone

2
00:00:10,310 --> 00:00:07,770
welcome to the nai director seminar this

3
00:00:12,259 --> 00:00:10,320
is going to be the last director seminar

4
00:00:14,629 --> 00:00:12,269
before the summer break and we'll pick

5
00:00:17,900 --> 00:00:14,639
it up again at the end of September we

6
00:00:21,140 --> 00:00:17,910
are really privileged today to have

7
00:00:24,189 --> 00:00:21,150
David Blake of the nai aims team with us

8
00:00:26,720 --> 00:00:24,199
Dave as I'm sure most of the people

9
00:00:28,970 --> 00:00:26,730
listening to this and watching this know

10
00:00:30,439 --> 00:00:28,980
is the principal investigator on the

11
00:00:32,590 --> 00:00:30,449
chemin instrument which is going to fly

12
00:00:34,580 --> 00:00:32,600
to Mars on the Mars Science Laboratory

13
00:00:37,310 --> 00:00:34,590

and I was just looking at Dave's

14

00:00:39,290 --> 00:00:37,320

background and I think he has probably

15

00:00:42,170 --> 00:00:39,300

been a principal investigator and just

16

00:00:46,340 --> 00:00:42,180

about every RNA program addressing

17

00:00:49,190 --> 00:00:46,350

planetary science and astrobiology that

18

00:00:51,290 --> 00:00:49,200

nASA has ever had he's been a p.i in the

19

00:00:54,260 --> 00:00:51,300

exobiology program cosmochemistry

20

00:00:56,240 --> 00:00:54,270

ancient Mars meteorite program ace did

21

00:00:58,520 --> 00:00:56,250

Mars instrument development program

22

00:01:02,060 --> 00:00:58,530

upper atmosphere research program list

23

00:01:05,690 --> 00:01:02,070

just goes on and on so dave has had

24

00:01:08,690 --> 00:01:05,700

quite a successful career here at NASA

25

00:01:12,100 --> 00:01:08,700

he has in fact been here at NASA NASA

26
00:01:15,620 --> 00:01:12,110
Ames since he became an NRC fellow in

27
00:01:18,170 --> 00:01:15,630
1986 and has had a very distinguished

28
00:01:21,410 --> 00:01:18,180
career including presently being chief

29
00:01:24,830 --> 00:01:21,420
of the exobiology branch here at the

30
00:01:27,830 --> 00:01:24,840
center he has a bachelor's in biological

31
00:01:31,640 --> 00:01:27,840
sciences from Stanford and a master's in

32
00:01:34,069 --> 00:01:31,650
geological sciences from Michigan and a

33
00:01:36,190 --> 00:01:34,079
PhD in mineralogy from Michigan so Dave

34
00:01:37,880 --> 00:01:36,200
again represents the kind of

35
00:01:40,609 --> 00:01:37,890
interdisciplinarity within a single

36
00:01:43,880 --> 00:01:40,619
individual that we think we've invented

37
00:01:45,950 --> 00:01:43,890
here at nai but obviously it was

38
00:01:48,499 --> 00:01:45,960

invented long before us I people like

39

00:01:51,440 --> 00:01:48,509

Dave so without further ado I'll turn it

40

00:01:53,660 --> 00:01:51,450

over today bike thank actually i think

41

00:01:56,270 --> 00:01:53,670

it was invented here because my advisor

42

00:01:57,920 --> 00:01:56,280

when i graduated he the best thing he

43

00:02:02,270 --> 00:01:57,930

could say about me with that i was

44

00:02:03,940 --> 00:02:02,280

neither fish nor fowl whatever that

45

00:02:07,910 --> 00:02:03,950

means hopefully hopefully something good

46

00:02:10,699 --> 00:02:07,920

well I i wanted to talk a bit today

47

00:02:11,450 --> 00:02:10,709

about the chemin instrument and msl and

48

00:02:15,980 --> 00:02:11,460

one

49

00:02:17,750 --> 00:02:15,990

know that NASA wants all of us

50

00:02:21,980 --> 00:02:17,760

scientists to getting more involved with

51
00:02:24,620 --> 00:02:21,990
missions and I know the nii here at Ames

52
00:02:27,020 --> 00:02:24,630
is trying to do that by getting involved

53
00:02:30,140 --> 00:02:27,030
with Kevin and with ms I and I wanted

54
00:02:33,350 --> 00:02:30,150
all for that opportunity to do anyone

55
00:02:37,280 --> 00:02:33,360
who wanted to do that so let me begin by

56
00:02:39,110 --> 00:02:37,290
speaking a bit about about msl and what

57
00:02:41,270 --> 00:02:39,120
it is is going to mostly be boilerplate

58
00:02:43,280 --> 00:02:41,280
because I hope that you you know about

59
00:02:45,770 --> 00:02:43,290
that already and then I'll get into the

60
00:02:49,060 --> 00:02:45,780
chemin instrument and how this might be

61
00:02:56,320 --> 00:02:49,070
useful for what you folks are doing so

62
00:02:59,420 --> 00:02:56,330
okay let's start off well a NASA

63
00:03:02,140 --> 00:02:59,430

exploration program this is this is also

64

00:03:04,370 --> 00:03:02,150

pretty much boilerplate presently

65

00:03:07,790 --> 00:03:04,380

Phoenix is on the ground in getting some

66

00:03:09,380 --> 00:03:07,800

pretty good data and october two

67

00:03:12,250 --> 00:03:09,390

thousand nine is the launch of Mars

68

00:03:15,740 --> 00:03:12,260

Science Laboratory and it'll land in

69

00:03:17,450 --> 00:03:15,750

mid-2010 and be active on the surface

70

00:03:19,970 --> 00:03:17,460

hopefully for at least two years and

71

00:03:23,750 --> 00:03:19,980

then what happens after that no one

72

00:03:26,240 --> 00:03:23,760

knows depending upon what discoveries we

73

00:03:30,500 --> 00:03:26,250

make and and what NASA policy is at that

74

00:03:33,680 --> 00:03:30,510

time well msl and chemin science goals

75

00:03:35,870 --> 00:03:33,690

the MSL science objective is to explore

76
00:03:37,460 --> 00:03:35,880
and quantitatively assess a local region

77
00:03:41,050 --> 00:03:37,470
on the Mars surface as a potential

78
00:03:43,780 --> 00:03:41,060
habitat for past or present life and

79
00:03:47,390 --> 00:03:43,790
there are four main science objectives

80
00:03:49,700 --> 00:03:47,400
assess the biological potential of a one

81
00:03:52,100 --> 00:03:49,710
target environment characterized the

82
00:03:54,920 --> 00:03:52,110
geology and geochemistry of the landed

83
00:03:56,800 --> 00:03:54,930
region investigate processes of

84
00:04:00,830 --> 00:03:56,810
relevance to past habitability and

85
00:04:02,570 --> 00:04:00,840
characterize surface radiation chemin is

86
00:04:04,940 --> 00:04:02,580
going to be involved in three of those

87
00:04:06,680 --> 00:04:04,950
goals to starred ones here assess the

88
00:04:10,550 --> 00:04:06,690

biological potential characterize

89

00:04:15,890 --> 00:04:10,560

geology investigate processes relevant

90

00:04:18,110 --> 00:04:15,900

to past habitability so just to show you

91

00:04:20,510 --> 00:04:18,120

what MSL looks like in comparison to mur

92

00:04:23,480 --> 00:04:20,520

it's a lot bigger this is ms l in the

93

00:04:25,250 --> 00:04:23,490

front and the main difference aside from

94

00:04:27,530 --> 00:04:25,260

size you can see is

95

00:04:30,770 --> 00:04:27,540

msl is operated with a radio thermal

96

00:04:34,960 --> 00:04:30,780

generator so its nuclear powered MSL is

97

00:04:37,400 --> 00:04:34,970

run or rather amigas or run by solar

98

00:04:39,170 --> 00:04:37,410

there's a size comparison i don't know

99

00:04:41,780 --> 00:04:39,180

if anybody really understands just how

100

00:04:44,270 --> 00:04:41,790

big this thing is but it just about

101
00:04:46,280 --> 00:04:44,280
dwarfs of mini cooper and i've never

102
00:04:49,160 --> 00:04:46,290
seen this close up but i've seen some of

103
00:04:52,700 --> 00:04:49,170
the onesies for testing the landing and

104
00:04:54,440 --> 00:04:52,710
the top of the surface just about his

105
00:04:56,930 --> 00:04:54,450
chest high on me and these wheels are

106
00:05:01,820 --> 00:04:56,940
about half a half a meter in diameter so

107
00:05:03,680 --> 00:05:01,830
it's it's big they started out there

108
00:05:06,920 --> 00:05:03,690
were coming up on our third landing site

109
00:05:10,180 --> 00:05:06,930
workshop the first landing site workshop

110
00:05:12,620 --> 00:05:10,190
there were something like 30 or 40

111
00:05:15,500 --> 00:05:12,630
individual sites proposed and these were

112
00:05:17,920 --> 00:05:15,510
investigated by high rise and some of

113
00:05:20,690 --> 00:05:17,930

the other orbital assets on Mars and

114

00:05:24,050 --> 00:05:20,700

they've been window down to six with the

115

00:05:25,610 --> 00:05:24,060

potential seven and you can look on the

116

00:05:28,730 --> 00:05:25,620

web and see what's interesting about

117

00:05:31,640 --> 00:05:28,740

each of these sites but they all have to

118

00:05:35,420 --> 00:05:31,650

do with either with water with with

119

00:05:39,710 --> 00:05:35,430

either phyllosilicates or with the

120

00:05:41,390 --> 00:05:39,720

sulfates here's the MSL payload there's

121

00:05:44,060 --> 00:05:41,400

there's four elements to it there's a

122

00:05:47,540 --> 00:05:44,070

remote sensing element which has a mask

123

00:05:50,600 --> 00:05:47,550

am similar to what the mers have a chem

124

00:05:52,520 --> 00:05:50,610

cam which is a Laser ionization tool

125

00:05:56,690 --> 00:05:52,530

where you can actually see compositions

126

00:05:59,090 --> 00:05:56,700

at a distance then there are contacts

127

00:06:01,190 --> 00:05:59,100

instruments including the Molly Kenna

128

00:06:04,420 --> 00:06:01,200

Jets instrument which is for microscopic

129

00:06:08,720 --> 00:06:04,430

imaging it's like a geologist hand lens

130

00:06:10,640 --> 00:06:08,730

the apxs which is flown on the Merse and

131

00:06:13,250 --> 00:06:10,650

it will tell you elemental composition

132

00:06:15,620 --> 00:06:13,260

and then inside the body of the rover

133

00:06:18,820 --> 00:06:15,630

there are two analytical instruments the

134

00:06:22,340 --> 00:06:18,830

Sam instrument which is a GC mass spec

135

00:06:24,170 --> 00:06:22,350

from Paul Mahaffy at Goddard that's kind

136

00:06:28,010 --> 00:06:24,180

of like the 500-pound gorilla on the

137

00:06:32,480 --> 00:06:28,020

payload then Kevin is also inside there

138

00:06:35,300 --> 00:06:32,490

and it's about a 10 kilogram xrd XRF

139

00:06:37,210 --> 00:06:35,310

instrument and then right around the

140

00:06:39,660 --> 00:06:37,220

around the outside of the land

141

00:06:41,920 --> 00:06:39,670

or the rover there's the Marty

142

00:06:44,620 --> 00:06:41,930

instrument which is strictly for descent

143

00:06:48,220 --> 00:06:44,630

imagery there's the Rams instrument

144

00:06:49,840 --> 00:06:48,230

which is a meteorology tool for

145

00:06:53,410 --> 00:06:49,850

determining wind speed and so forth

146

00:06:55,150 --> 00:06:53,420

there's the rad instrument which tells

147

00:06:57,640 --> 00:06:55,160

you about radiation on the surface and

148

00:07:00,700 --> 00:06:57,650

then there's the Dan instrument which is

149

00:07:04,300 --> 00:07:00,710

a neutron generator and detector to

150

00:07:10,360 --> 00:07:04,310

determine subsurface hydrogen and I was

151

00:07:12,130 --> 00:07:10,370

talking to Dmitry metropolis and the

152

00:07:13,300 --> 00:07:12,140

interesting thing about the Dan is that

153

00:07:15,700 --> 00:07:13,310

this really is swords to plowshares

154

00:07:17,620 --> 00:07:15,710

because the neutron generator and that

155

00:07:19,090 --> 00:07:17,630

thing is a nuclear trigger from a

156

00:07:21,550 --> 00:07:19,100

Russian atomic bomb so I thought that

157

00:07:22,990 --> 00:07:21,560

was I was pretty interesting I'd like to

158

00:07:26,080 --> 00:07:23,000

see the u.s. pull that kind of a thing

159

00:07:30,250 --> 00:07:26,090

off on a Russian mission okay let's get

160

00:07:33,250 --> 00:07:30,260

to chemin well the I'm the pie and it's

161

00:07:36,610 --> 00:07:33,260

being built by JPL but it's it's coming

162

00:07:39,100 --> 00:07:36,620

out of an answer research center there

163

00:07:42,430 --> 00:07:39,110

is a microphone okis x-ray tube that

164

00:07:44,740 --> 00:07:42,440

produces a small beam about 50 microns

165

00:07:47,980 --> 00:07:44,750

in diameter that goes through pennell

166

00:07:49,690 --> 00:07:47,990

collimator to illuminate the the sample

167

00:07:51,400 --> 00:07:49,700

sale here which consists of two thin

168

00:07:54,550 --> 00:07:51,410

plastic windows with fine grain material

169

00:07:58,110 --> 00:07:54,560

in between and then the photons are

170

00:08:01,570 --> 00:07:58,120

detected by this x-ray sensitive ccd and

171

00:08:03,670 --> 00:08:01,580

i'll talk more about this later but just

172

00:08:07,330 --> 00:08:03,680

to say now that chemin is able to do

173

00:08:08,650 --> 00:08:07,340

definitive mineralogy and be able to

174

00:08:11,350 --> 00:08:08,660

determine all possible all the minerals

175

00:08:12,850 --> 00:08:11,360

that are on Mars and if we don't know if

176

00:08:14,380 --> 00:08:12,860

we find a mineral that we didn't see

177

00:08:18,700 --> 00:08:14,390

before we'll be able to name it and tell

178

00:08:21,940 --> 00:08:18,710

you what it is here's the most recent

179

00:08:24,040 --> 00:08:21,950

picture of the rover the main things

180

00:08:28,870 --> 00:08:24,050

that have changed our things around the

181

00:08:31,900 --> 00:08:28,880

SAS bow on the arm here nothing to much

182

00:08:33,760 --> 00:08:31,910

of interest chemin is sitting inside the

183

00:08:36,040 --> 00:08:33,770

rover and there's a little access port

184

00:08:37,959 --> 00:08:36,050

right about here when they generate

185

00:08:40,180 --> 00:08:37,969

material for us they open a little

186

00:08:44,110 --> 00:08:40,190

access port dump in the material and

187

00:08:47,860 --> 00:08:44,120

then we analyze it so here's the summary

188

00:08:49,960 --> 00:08:47,870

of spreadsheet of Investigations versus

189

00:08:50,950 --> 00:08:49,970

objectives these are all the objectives

190

00:08:52,990 --> 00:08:50,960

on this

191

00:08:55,990 --> 00:08:53,000

of what MSL was supposed to do and

192

00:08:58,750 --> 00:08:56,000

here's the the various ways that the

193

00:08:59,890 --> 00:08:58,760

instruments support those objectives so

194

00:09:01,750 --> 00:08:59,900

you can see there's a lot of redundancy

195

00:09:05,920 --> 00:09:01,760

in the package and that's kind of like

196

00:09:07,750 --> 00:09:05,930

what they were going for so not like to

197

00:09:11,370 --> 00:09:07,760

go into the mineralogy aspect to this

198

00:09:13,930 --> 00:09:11,380

why do we care about mineralogy on Mars

199

00:09:15,940 --> 00:09:13,940

mineralogy is it really the only means

200

00:09:18,910 --> 00:09:15,950

to lucid eight environments in the

201

00:09:20,830 --> 00:09:18,920

geologically ancient past minerals are

202

00:09:23,530 --> 00:09:20,840

thermodynamic phases and by that I mean

203

00:09:24,910 --> 00:09:23,540

that they form under certain conditions

204

00:09:28,690 --> 00:09:24,920

of temperature pressure and Composition

205

00:09:30,760 --> 00:09:28,700

and by seeing a mineral with it you can

206

00:09:33,700 --> 00:09:30,770

tell what pressure temperature and

207

00:09:37,240 --> 00:09:33,710

Composition surrounded it when it was

208

00:09:38,770 --> 00:09:37,250

formed the second thing that's that

209

00:09:41,890 --> 00:09:38,780

helps us is that solid state

210

00:09:44,590 --> 00:09:41,900

transformations are sluggish so minerals

211

00:09:46,810 --> 00:09:44,600

quite often stay in an unrequited state

212

00:09:49,030 --> 00:09:46,820

after their forms so we can see them and

213

00:09:50,620 --> 00:09:49,040

know what condition they were formed and

214

00:09:52,750 --> 00:09:50,630

even even though they're present now in

215

00:09:54,190 --> 00:09:52,760

a different condition so if you happen

216

00:09:55,990 --> 00:09:54,200

to find a diamond on the ground which

217

00:09:57,670 --> 00:09:56,000

would be a good thing you could say that

218

00:09:59,110 --> 00:09:57,680

that diamond was not formed in that

219

00:10:03,390 --> 00:09:59,120

environment it was informed in a

220

00:10:05,860 --> 00:10:03,400

high-pressure environment somewhere else

221

00:10:08,410 --> 00:10:05,870

secondly our thirdly rather relic

222

00:10:11,530 --> 00:10:08,420

biological information might be cryptic

223

00:10:14,910 --> 00:10:11,540

and so you need to have mineralogy to

224

00:10:17,940 --> 00:10:14,920

find the rocks that may have a relic by

225

00:10:20,530 --> 00:10:17,950

bio information inside of them so

226

00:10:23,590 --> 00:10:20,540

mineralogy is a good tool to find what

227

00:10:26,020 --> 00:10:23,600

rocks might contain bio signatures

228

00:10:27,730 --> 00:10:26,030

within them and then lastly weathering

229

00:10:29,830 --> 00:10:27,740

and diagenesis might only leave the

230

00:10:33,610 --> 00:10:29,840

mineral component of a biological

231

00:10:34,960 --> 00:10:33,620

process the the phrase I like to say is

232

00:10:37,060 --> 00:10:34,970

that anything older than a few million

233

00:10:39,490 --> 00:10:37,070

years on Mars is either going to be Iraq

234

00:10:40,750 --> 00:10:39,500

or it's only going to be interpreted

235

00:10:45,610 --> 00:10:40,760

well in terms of the rocks that contain

236

00:10:49,030 --> 00:10:45,620

it so let's talk about mineralogy in the

237

00:10:52,690 --> 00:10:49,040

context of some rocks that were seen by

238

00:10:56,350 --> 00:10:52,700

the rover's here you see a table of a

239

00:10:58,090 --> 00:10:56,360

bunch of rocks from Gusev crater these

240

00:11:01,030 --> 00:10:58,100

are watched what called watched our

241

00:11:03,700 --> 00:11:01,040

class rocks there's Keystone keel davis

242

00:11:06,940 --> 00:11:03,710

Watchtower Pequod and pero

243

00:11:09,550 --> 00:11:06,950

and you can see from the apx data here

244

00:11:12,910 --> 00:11:09,560

they're all pretty much the same

245

00:11:14,200 --> 00:11:12,920

chemically so if you do a px of all of

246

00:11:17,230 --> 00:11:14,210

these rocks they all pretty much look

247

00:11:19,330 --> 00:11:17,240

the same but over here you see mas power

248

00:11:21,460 --> 00:11:19,340

results and each one of these colors

249

00:11:24,010 --> 00:11:21,470

represents a different iron mineral and

250

00:11:27,040 --> 00:11:24,020

you can see that the mineralogy of these

251

00:11:29,500 --> 00:11:27,050

rocks at least when looked at from a

252

00:11:31,900 --> 00:11:29,510

mineralogical perspective they from from

253

00:11:34,810 --> 00:11:31,910

the iron minerals rather are very

254

00:11:38,500 --> 00:11:34,820

diverse so mineralogy will tell you the

255

00:11:40,930 --> 00:11:38,510

dye vs. but the diverse environments of

256

00:11:45,550 --> 00:11:40,940

a surface whereas chemical composition

257

00:11:47,380 --> 00:11:45,560

alone might not so here's the chemin

258

00:11:50,530 --> 00:11:47,390

principle chemin stands for chemistry

259

00:11:53,830 --> 00:11:50,540

and mineralogy it uses x-ray diffraction

260

00:11:55,420 --> 00:11:53,840

for mineralogical determinations x-ray

261

00:11:58,060 --> 00:11:55,430

fluorescence for elemental

262

00:12:01,570 --> 00:11:58,070

characterization a single detector for

263

00:12:03,910 --> 00:12:01,580

both measurements and no moving parts in

264

00:12:05,590 --> 00:12:03,920

about 20 milligrams sample size so it's

265

00:12:09,040 --> 00:12:05,600

a little bit smaller than a baby aspirin

266

00:12:11,800 --> 00:12:09,050

tablet size of sample so now I'll give

267

00:12:15,580 --> 00:12:11,810

you a little brief insight into how it

268

00:12:18,130 --> 00:12:15,590

works cobalt x-ray tube microfocuss tube

269

00:12:20,620 --> 00:12:18,140

it a beam starts here at about 50

270

00:12:22,780 --> 00:12:20,630

microns diameter there is a pinhole

271

00:12:25,870 --> 00:12:22,790

kilometer which produces a collimated

272

00:12:29,350 --> 00:12:25,880

proximately 50 micron source it goes

273

00:12:31,150 --> 00:12:29,360

through a thin too thin plastic films

274

00:12:33,790 --> 00:12:31,160

which contain the sample between them

275

00:12:37,150 --> 00:12:33,800

the sample consists of 150 microns and

276
00:12:40,180 --> 00:12:37,160
below crush powders and this whole thing

277
00:12:42,580 --> 00:12:40,190
is shaken so that the the powder flows

278
00:12:45,160 --> 00:12:42,590
like liquid inside this cell so that in

279
00:12:47,950 --> 00:12:45,170
over a period of time all the grains

280
00:12:50,050 --> 00:12:47,960
fast through this tiny beam in random

281
00:12:52,840 --> 00:12:50,060
orientations and as they pass through

282
00:12:55,510 --> 00:12:52,850
the beam two possible things can happen

283
00:12:57,850 --> 00:12:55,520
nothing can happen of course but one

284
00:12:59,890 --> 00:12:57,860
possible thing is diffraction and the

285
00:13:04,120 --> 00:12:59,900
diffracted beam the form these lousy

286
00:13:06,040 --> 00:13:04,130
rings on the ccd detector here the

287
00:13:09,520 --> 00:13:06,050
second thing that can happen is that you

288
00:13:11,410 --> 00:13:09,530

can get x-ray fluorescence and photons

289

00:13:13,480 --> 00:13:11,420

are emitted from the sample which have

290

00:13:16,120 --> 00:13:13,490

energies which tell you what element

291

00:13:17,290 --> 00:13:16,130

elements are in the sample and so this

292

00:13:20,139 --> 00:13:17,300

detector can

293

00:13:23,410 --> 00:13:20,149

both of those signals at once if you if

294

00:13:26,110 --> 00:13:23,420

you do a dative plot which is basically

295

00:13:28,480 --> 00:13:26,120

from the center outwards of these

296

00:13:30,970 --> 00:13:28,490

photons that are striking the Rings then

297

00:13:34,230 --> 00:13:30,980

you will get this this thing here this

298

00:13:37,750 --> 00:13:34,240

one dimensional plot diffractograms and

299

00:13:39,130 --> 00:13:37,760

this will tell you what spacings are

300

00:13:41,769 --> 00:13:39,140

present in all the minerals that are

301
00:13:43,509 --> 00:13:41,779
contained in the sample if you just take

302
00:13:45,340 --> 00:13:43,519
all the energies of the photons and

303
00:13:47,620 --> 00:13:45,350
strike the chip and make a histogram

304
00:13:49,269 --> 00:13:47,630
down here this will tell you all the

305
00:13:51,130 --> 00:13:49,279
elements at our present so with these

306
00:13:53,079 --> 00:13:51,140
two measurements you can tell the

307
00:13:55,540 --> 00:13:53,089
composition and scent of the sample from

308
00:13:56,829 --> 00:13:55,550
the x-ray fluorescence and the structure

309
00:14:01,300 --> 00:13:56,839
of the sample from the diffraction

310
00:14:03,430 --> 00:14:01,310
information so now that we know that

311
00:14:05,230 --> 00:14:03,440
what what we know the geometry it's a

312
00:14:07,509 --> 00:14:05,240
transmission geometry now we have to

313
00:14:09,579 --> 00:14:07,519

worry about the details of where do we

314

00:14:12,340 --> 00:14:09,589

want to look what what to theta angles

315

00:14:14,259 --> 00:14:12,350

what range what resolution we know that

316

00:14:16,780 --> 00:14:14,269

we would like to see in the low to theta

317

00:14:18,100 --> 00:14:16,790

regions because we want to see clays and

318

00:14:21,220 --> 00:14:18,110

that's where the principal peaks of

319

00:14:23,590 --> 00:14:21,230

clays are located here's xrd pattern of

320

00:14:25,210 --> 00:14:23,600

smectite and you can see this is the

321

00:14:27,730 --> 00:14:25,220

principle peak of smectite and that's

322

00:14:30,340 --> 00:14:27,740

located down around five or six degrees

323

00:14:32,980 --> 00:14:30,350

two theta so we want to have an angular

324

00:14:34,720 --> 00:14:32,990

range that will encompass place we also

325

00:14:39,639 --> 00:14:34,730

want to go out far enough to encompass

326

00:14:41,560 --> 00:14:39,649

other other minerals of interest so we

327

00:14:43,300 --> 00:14:41,570

this is a little bit of Monday morning

328

00:14:44,860 --> 00:14:43,310

quarterbacking we actually knew where we

329

00:14:46,630 --> 00:14:44,870

wanted to go with this instrument but

330

00:14:50,530 --> 00:14:46,640

when we went through the science peer

331

00:14:53,319 --> 00:14:50,540

review down at JPL to justify our to

332

00:14:55,449 --> 00:14:53,329

theta range we took a mineral model of

333

00:14:58,540 --> 00:14:55,459

the piece outcrop and the Columbia Hills

334

00:15:00,400 --> 00:14:58,550

done by Doug Ming this shows you each

335

00:15:02,650 --> 00:15:00,410

one of the minerals that were present in

336

00:15:05,519 --> 00:15:02,660

that model forsterite which is an

337

00:15:07,650 --> 00:15:05,529

olivene augite which is a Pyrrhic seen

338

00:15:11,530 --> 00:15:07,660

labradorite which is a feldspar

339

00:15:13,660 --> 00:15:11,540

magnetite claire appetite Kizer right

340

00:15:16,300 --> 00:15:13,670

gypsum and this is all of them together

341

00:15:19,480 --> 00:15:16,310

this shows the major peaks all these

342

00:15:21,340 --> 00:15:19,490

small lines for each mineral you can see

343

00:15:22,990 --> 00:15:21,350

there are very complex ones like the

344

00:15:25,660 --> 00:15:23,000

labradorite which has a lot of lines

345

00:15:28,389 --> 00:15:25,670

together simple ones like magnetite

346

00:15:31,150 --> 00:15:28,399

which is a cubic feet or rather cubic

347

00:15:33,670 --> 00:15:31,160

phase when you put them all together you

348

00:15:35,470 --> 00:15:33,680

kind of a mishmash here and the main

349

00:15:38,050 --> 00:15:35,480

point we wanted to make with this is

350

00:15:41,650 --> 00:15:38,060

that if you look at the two theta range

351
00:15:43,329 --> 00:15:41,660
from about 5 out to about 50 you can get

352
00:15:46,540 --> 00:15:43,339
all the major peaks of interest for

353
00:15:49,059 --> 00:15:46,550
these phases okay so let's go on to look

354
00:15:51,730 --> 00:15:49,069
at what kind of we know we know the

355
00:15:54,639 --> 00:15:51,740
range of 2θ we want what kind of

356
00:15:56,050 --> 00:15:54,649
resolution do we want and we can't just

357
00:15:58,210 --> 00:15:56,060
have the best resolution possible

358
00:16:01,090 --> 00:15:58,220
because resolution is inversely

359
00:16:03,730 --> 00:16:01,100
proportional to count rate so we want to

360
00:16:06,759 --> 00:16:03,740
have the basically the worst resolution

361
00:16:10,420 --> 00:16:06,769
that will give us the answer that we can

362
00:16:14,050 --> 00:16:10,430
live with so what we did is we we made a

363
00:16:17,350 --> 00:16:14,060

model of these minerals and use various

364

00:16:19,660 --> 00:16:17,360

resolutions here from point 3 I know you

365

00:16:22,210 --> 00:16:19,670

can't see the colors here all together

366

00:16:24,699 --> 00:16:22,220

with 0 point 3 to about point six

367

00:16:27,730 --> 00:16:24,709

degrees two theta and if we go to the

368

00:16:30,579 --> 00:16:27,740

next slide here we'll just look at a

369

00:16:33,220 --> 00:16:30,589

small range from 30 to 32 degrees two

370

00:16:35,069 --> 00:16:33,230

theta you can see that as we go from

371

00:16:38,410 --> 00:16:35,079

about point three degrees two theta

372

00:16:40,600 --> 00:16:38,420

downward we start to lose the ability to

373

00:16:44,499 --> 00:16:40,610

distinguish these peaks and therefore to

374

00:16:46,150 --> 00:16:44,509

distinguish these minerals so we were as

375

00:16:49,150 --> 00:16:46,160

we would like to have the very best

376

00:16:51,790 --> 00:16:49,160

possible resolution on this instrument

377

00:16:53,889 --> 00:16:51,800

we can put up with between about point

378

00:16:56,350 --> 00:16:53,899

three and point three five and actually

379

00:17:00,280 --> 00:16:56,360

do the job and just for comparison a

380

00:17:03,040 --> 00:17:00,290

laboratory diffractometer that you might

381

00:17:05,409 --> 00:17:03,050

buy has a full with half max of about

382

00:17:07,510 --> 00:17:05,419

point one so we're about three times

383

00:17:09,850 --> 00:17:07,520

worse than a laboratory diffractometer

384

00:17:13,179 --> 00:17:09,860

but nevertheless we're able to do what

385

00:17:17,230 --> 00:17:13,189

we say we can do and here's an example

386

00:17:21,340 --> 00:17:17,240

of a data set from from a typical chemin

387

00:17:24,100 --> 00:17:21,350

run here's the 2d energy filtered xrd

388

00:17:27,039 --> 00:17:24,110

pattern and here is the diffractograms

389

00:17:29,620 --> 00:17:27,049

that was obtained from that pattern this

390

00:17:31,690 --> 00:17:29,630

is what's called a repelled refinement

391

00:17:34,510 --> 00:17:31,700

which is a both pattern fitting with

392

00:17:37,210 --> 00:17:34,520

like where's refinement and by doing

393

00:17:40,539 --> 00:17:37,220

this kind of a quantitative analysis you

394

00:17:42,880 --> 00:17:40,549

can get a fully quantitative analysis of

395

00:17:46,300 --> 00:17:42,890

all the minerals that are present there

396

00:17:48,010 --> 00:17:46,310

this was done by Dave fish at Indiana

397

00:17:50,560 --> 00:17:48,020

University who's one of the people on

398

00:17:53,140 --> 00:17:50,570

our team you can also get friending more

399

00:17:54,820 --> 00:17:53,150

than about ten percent president about

400

00:17:57,460 --> 00:17:54,830

ten percent composition you can get

401
00:17:59,170 --> 00:17:57,470
refined lattice parameters and with

402
00:18:01,450 --> 00:17:59,180
refined lattice parameters with things

403
00:18:03,880 --> 00:18:01,460
like olive eens you can tell the iron

404
00:18:06,460 --> 00:18:03,890
magnesium ratio and so forth and then

405
00:18:08,500 --> 00:18:06,470
here's the x-ray fluorescence pattern

406
00:18:10,840 --> 00:18:08,510
from this sample this particular camera

407
00:18:12,520 --> 00:18:10,850
have a bit of iron contamination we want

408
00:18:15,220 --> 00:18:12,530
to really have that issue on a myself

409
00:18:20,320 --> 00:18:15,230
but that's what a standard data set will

410
00:18:23,470 --> 00:18:20,330
look like now now that we know what full

411
00:18:25,600 --> 00:18:23,480
range and all that is necessary what

412
00:18:28,780 --> 00:18:25,610
kind of accuracy and precision do we

413
00:18:32,230 --> 00:18:28,790

want this shows the accuracy of the

414

00:18:34,780 --> 00:18:32,240

chemcam instrument and the apxs and the

415

00:18:36,310 --> 00:18:34,790

precision and we picked an accuracy of

416

00:18:38,590 --> 00:18:36,320

about fifteen percent of the amount

417

00:18:41,110 --> 00:18:38,600

present we can actually do better than

418

00:18:42,580 --> 00:18:41,120

that but this is our requirement this is

419

00:18:47,620 --> 00:18:42,590

what we have to show in order to be

420

00:18:51,010 --> 00:18:47,630

fully responsive to to to our contract

421

00:18:52,960 --> 00:18:51,020

and a ten percent precision with a

422

00:18:54,790 --> 00:18:52,970

minimum detection level of about three

423

00:18:56,500 --> 00:18:54,800

percent and we can actually do better

424

00:19:02,260 --> 00:18:56,510

than this but this is what we signed up

425

00:19:04,420 --> 00:19:02,270

for here's a couple of examples this is

426

00:19:08,170 --> 00:19:04,430

a Hawaiian soil collected collected by

427

00:19:10,840 --> 00:19:08,180

Dick Morris it shows the minerals

428

00:19:13,360 --> 00:19:10,850

present down here this shows what are

429

00:19:15,640 --> 00:19:13,370

our trial horse chemin pour instrument

430

00:19:18,700 --> 00:19:15,650

was able to obtain this is a standard

431

00:19:20,290 --> 00:19:18,710

x-ray diffractometer analysis this is

432

00:19:22,750 --> 00:19:20,300

the percentage difference between the

433

00:19:26,080 --> 00:19:22,760

two and this is our evaluation so

434

00:19:29,860 --> 00:19:26,090

basically all of the phases that are

435

00:19:33,340 --> 00:19:29,870

above three percent are within fifteen

436

00:19:35,620 --> 00:19:33,350

percent this same orifice face here we

437

00:19:37,450 --> 00:19:35,630

had a little difficulty with and we knew

438

00:19:39,580 --> 00:19:37,460

all along we have difficulty with

439

00:19:42,190 --> 00:19:39,590

amorphous materials and we're developing

440

00:19:44,950 --> 00:19:42,200

models for that the rough these are

441

00:19:47,200 --> 00:19:44,960

below the minimum detection limits with

442

00:19:49,450 --> 00:19:47,210

with exception of kaolin iden and clays

443

00:19:51,010 --> 00:19:49,460

were we can't quite do what we say we

444

00:19:55,750 --> 00:19:51,020

can do we're more like ten percent with

445

00:19:57,340 --> 00:19:55,760

plays here's another example is a

446

00:19:59,770 --> 00:19:57,350

synthetic clay bettering

447

00:20:03,700 --> 00:19:59,780

right and here again there's none

448

00:20:06,130 --> 00:20:03,710

tonight gypsum halite hematite that's

449

00:20:08,470 --> 00:20:06,140

what Kevin for data produced that's the

450

00:20:10,930 --> 00:20:08,480

known mixture and this is the deviation

451
00:20:13,029 --> 00:20:10,940
in percent and these are all within our

452
00:20:19,029 --> 00:20:13,039
stated precision and accuracy of

453
00:20:20,560 --> 00:20:19,039
analysis okay so I was interested to see

454
00:20:23,140 --> 00:20:20,570
what we could do with some amorphous

455
00:20:24,789 --> 00:20:23,150
materials so I got together I don't

456
00:20:26,680 --> 00:20:24,799
really think you can probably see the

457
00:20:28,539 --> 00:20:26,690
labels very well but I got together as

458
00:20:32,039 --> 00:20:28,549
many Amorphis silica materials as I

459
00:20:34,600 --> 00:20:32,049
could this was to kind of look at

460
00:20:37,360 --> 00:20:34,610
similar materials to thee to the

461
00:20:41,080 --> 00:20:37,370
amorphous silica that they saw at home

462
00:20:45,789 --> 00:20:41,090
plate in maury so the lot the lines here

463
00:20:47,500 --> 00:20:45,799

you see there's opal a which is right

464

00:20:51,640 --> 00:20:47,510

there let's see I believe that so play

465

00:20:54,840 --> 00:20:51,650

right there opal CT a few silica in the

466

00:20:59,399 --> 00:20:54,850

red and guys are right in the dark blue

467

00:21:02,110 --> 00:20:59,409

down here here's a fulgurite which is a

468

00:21:05,220 --> 00:21:02,120

lightning strike amorphous ports it's

469

00:21:08,500 --> 00:21:05,230

when lightning strikes sandstone

470

00:21:11,860 --> 00:21:08,510

then there's moldavite here moldavite is

471

00:21:14,529 --> 00:21:11,870

from Moldavia Czechoslovakia that's

472

00:21:17,020 --> 00:21:14,539

basically a tektite like material caused

473

00:21:19,529 --> 00:21:17,030

by me right impact and then here's a

474

00:21:24,340 --> 00:21:19,539

tektite that I bought at the AG you and

475

00:21:28,210 --> 00:21:24,350

then over here is a couple of ash ash

476

00:21:29,440 --> 00:21:28,220

fall tips from New Mexico so basically

477

00:21:31,659 --> 00:21:29,450

the point I want to make even without

478

00:21:33,010 --> 00:21:31,669

looking into the details is every single

479

00:21:35,230 --> 00:21:33,020

one of these is different and we can

480

00:21:37,409 --> 00:21:35,240

quantitatively analyze even amorphous

481

00:21:40,360 --> 00:21:37,419

materials and tell you what they are

482

00:21:42,940 --> 00:21:40,370

okay so let's move on a bit here here's

483

00:21:45,580 --> 00:21:42,950

a little heritage of what of what we've

484

00:21:49,390 --> 00:21:45,590

done since 1991 this was our first

485

00:21:51,760 --> 00:21:49,400

instrument built off big Phillips tube

486

00:21:53,470 --> 00:21:51,770

tower the weight of the instruments 500

487

00:21:57,700 --> 00:21:53,480

kilograms that obviously was going to go

488

00:22:00,220 --> 00:21:57,710

anywhere on 2002 we got a bit better

489

00:22:03,960 --> 00:22:00,230

x-ray tube and power supply we dropped

490

00:22:06,640 --> 00:22:03,970

wait a little bit to 100 kilograms and

491

00:22:09,130 --> 00:22:06,650

2004 when we started getting our major

492

00:22:10,150 --> 00:22:09,140

funding we were able to make a field

493

00:22:13,450 --> 00:22:10,160

instrument which

494

00:22:15,070 --> 00:22:13,460

about 30 kilograms and we actually took

495

00:22:17,650 --> 00:22:15,080

this out to death valley and did some

496

00:22:20,050 --> 00:22:17,660

tests with it from there we moved on in

497

00:22:22,930 --> 00:22:20,060

two directions this was used as a trial

498

00:22:25,030 --> 00:22:22,940

horse to build the Mars instrument which

499

00:22:27,280 --> 00:22:25,040

is over here it's actually being put

500

00:22:31,150 --> 00:22:27,290

together now and will be delivered by

501
00:22:32,500 --> 00:22:31,160
JPL in September and it's pretty pretty

502
00:22:34,420 --> 00:22:32,510
interesting to go down and clean room

503
00:22:36,640 --> 00:22:34,430
and put a little your cleanroom garb on

504
00:22:38,740 --> 00:22:36,650
and let's see what they're up to it's

505
00:22:41,740 --> 00:22:38,750
like having your own space shuttle bill

506
00:22:43,780 --> 00:22:41,750
for you it's just a lot of fun over here

507
00:22:46,030 --> 00:22:43,790
shows the second course we went with

508
00:22:48,880 --> 00:22:46,040
this Philippe Sarah's and who was my

509
00:22:50,770 --> 00:22:48,890
postdoc years ago started a little

510
00:22:53,380 --> 00:22:50,780
company called in situ in Mountain View

511
00:22:56,980 --> 00:22:53,390
and he's still working with me he's a co

512
00:22:58,690 --> 00:22:56,990
I on chemin and he's building these what

513
00:23:01,090 --> 00:22:58,700

we're now calling Tara instruments which

514

00:23:03,070 --> 00:23:01,100

are merciless a labelled and they are

515

00:23:06,100 --> 00:23:03,080

instruments with the same geometry as

516

00:23:07,510 --> 00:23:06,110

the chemin instrument but can be taken

517

00:23:11,140 --> 00:23:07,520

in the field they're filled ruggedized

518

00:23:15,430 --> 00:23:11,150

and and user-friendly so let's go on

519

00:23:17,530 --> 00:23:15,440

here's our to our trial horses this is

520

00:23:20,590 --> 00:23:17,540

our chem and for instrument which we use

521

00:23:22,480 --> 00:23:20,600

to benchmark the MSL instrument then

522

00:23:24,550 --> 00:23:22,490

this is a bit more user-friendly

523

00:23:26,650 --> 00:23:24,560

instrument are Terra instrument that's

524

00:23:30,790 --> 00:23:26,660

that we took out in the field for the

525

00:23:35,140 --> 00:23:30,800

first time in Spitsbergen last year this

526
00:23:36,550 --> 00:23:35,150
one wait about 30 kilograms and bishan

527
00:23:39,100 --> 00:23:36,560
ik daar dunnnnn off a mountain in

528
00:23:41,140 --> 00:23:39,110
Spitsbergen in 2006 and about I about

529
00:23:43,330 --> 00:23:41,150
died I knew that was not going to be the

530
00:23:45,250 --> 00:23:43,340
way we were going to go so that was a

531
00:23:47,230 --> 00:23:45,260
major driving force for getting down to

532
00:23:49,900 --> 00:23:47,240
something a bit smaller which is over

533
00:23:52,440 --> 00:23:49,910
here this is still not easy to carry

534
00:23:54,400 --> 00:23:52,450
around it's about 15 kilograms but

535
00:23:58,120 --> 00:23:54,410
certainly a lot better than it used to

536
00:24:01,780 --> 00:23:58,130
be so here's a comparison with what is

537
00:24:03,850 --> 00:24:01,790
available commercially this is a portion

538
00:24:06,010 --> 00:24:03,860

of a rigaku mini flex instrument and

539

00:24:07,870 --> 00:24:06,020

what you don't see in the picture is a

540

00:24:09,910 --> 00:24:07,880

one kilowatt generator and a water

541

00:24:12,190 --> 00:24:09,920

circulator that has to also be set up

542

00:24:16,570 --> 00:24:12,200

with it and this is Ron Peterson the

543

00:24:18,460 --> 00:24:16,580

discoverer of meridiani aight up in

544

00:24:20,290 --> 00:24:18,470

canada in the wintertime so we went up

545

00:24:21,160 --> 00:24:20,300

with him this year and this is what he

546

00:24:24,760 --> 00:24:21,170

took and this is

547

00:24:26,890 --> 00:24:24,770

the incision Tara instrument so the this

548

00:24:28,900 --> 00:24:26,900

instrument is about ten to a hundred

549

00:24:30,820 --> 00:24:28,910

times smaller and all that other

550

00:24:35,050 --> 00:24:30,830

business than than anything else it's

551
00:24:38,050 --> 00:24:35,060
available here's Dave fish this is the

552
00:24:41,050 --> 00:24:38,060
first time when we took chemin for out

553
00:24:43,630 --> 00:24:41,060
to Death Valley to just do some cameo

554
00:24:45,730 --> 00:24:43,640
shots and do some demos we didn't really

555
00:24:48,490 --> 00:24:45,740
take it out there with the idea of doing

556
00:24:50,740 --> 00:24:48,500
science we really took it out there I

557
00:24:52,270 --> 00:24:50,750
wouldn't say as a publicity stunt but

558
00:24:54,160 --> 00:24:52,280
just to show we could do it to show we

559
00:24:57,310 --> 00:24:54,170
could actually take in and swim the

560
00:25:00,940 --> 00:24:57,320
field of gather data Spitsbergen small

561
00:25:04,240 --> 00:25:00,950
barred in 2006 we came out here to

562
00:25:07,360 --> 00:25:04,250
really do science so here's Dave fish on

563
00:25:09,910 --> 00:25:07,370

the top of Sierra fell with our chemin

564

00:25:11,740 --> 00:25:09,920

for instrument its first time anyone

565

00:25:14,200 --> 00:25:11,750

ever did a quantitative analysis in the

566

00:25:16,630 --> 00:25:14,210

field and what we found is there are

567

00:25:18,580 --> 00:25:16,640

some really useful things you can do you

568

00:25:20,710 --> 00:25:18,590

can actually actively generate

569

00:25:22,630 --> 00:25:20,720

hypotheses and test them in the field

570

00:25:25,810 --> 00:25:22,640

along with other people using other

571

00:25:27,460 --> 00:25:25,820

techniques you can identify ephemeral

572

00:25:29,470 --> 00:25:27,470

phases that aren't going to last longer

573

00:25:31,300 --> 00:25:29,480

than a few minutes or a few hours

574

00:25:34,030 --> 00:25:31,310

certainly not long enough to take them

575

00:25:36,940 --> 00:25:34,040

to the lab and you can go through just a

576

00:25:38,680 --> 00:25:36,950

myriad of samples and find samples that

577

00:25:40,540 --> 00:25:38,690

you really want and not have to carry

578

00:25:44,320 --> 00:25:40,550

back the samples that you don't want and

579

00:25:46,000 --> 00:25:44,330

this particularly is interesting for for

580

00:25:48,360 --> 00:25:46,010

example Doug Ming told me when he took

581

00:25:50,410 --> 00:25:48,370

our instrument down to Antarctica

582

00:25:52,330 --> 00:25:50,420

sometimes they don't get their samples

583

00:25:53,980 --> 00:25:52,340

back for a year so it's very good to

584

00:25:55,420 --> 00:25:53,990

make sure you know what you want and

585

00:25:59,290 --> 00:25:55,430

actually get some information on those

586

00:26:02,920 --> 00:25:59,300

samples when you're in the field so

587

00:26:05,800 --> 00:26:02,930

here's next year this is our chemin a

588

00:26:07,510 --> 00:26:05,810

rather are Terra instrument this this

589

00:26:09,730 --> 00:26:07,520

instrument actually philippe Saracen

590

00:26:11,830 --> 00:26:09,740

took this from a napkin drawing to

591

00:26:14,560 --> 00:26:11,840

carrying this on the airplane in six

592

00:26:17,890 --> 00:26:14,570

months and it's a very same instrument I

593

00:26:21,250 --> 00:26:17,900

have today this is on that same mountain

594

00:26:23,230 --> 00:26:21,260

up in Svalbard if you don't know where

595

00:26:25,050 --> 00:26:23,240

it is this is Pittsburgh and its way

596

00:26:28,660 --> 00:26:25,060

north this is the Arctic Circle here

597

00:26:30,250 --> 00:26:28,670

this is way up at about 80 north and the

598

00:26:32,500 --> 00:26:30,260

reason had that gun in the

599

00:26:34,010 --> 00:26:32,510

previous slide is because you really do

600

00:26:36,050 --> 00:26:34,020

have to watch out for polar bears

601
00:26:37,790 --> 00:26:36,060
up there we were actually interrupted by

602
00:26:40,310 --> 00:26:37,800
polar bears a couple of times while we

603
00:26:44,900 --> 00:26:40,320
were doing work here's our first example

604
00:26:46,880 --> 00:26:44,910
of what Spitsbergen anyway of why it's

605
00:26:49,310 --> 00:26:46,890
important to do mineralogy in the field

606
00:26:51,800 --> 00:26:49,320
and I know you can't see the details of

607
00:26:53,480 --> 00:26:51,810
these two patterns but but you can see

608
00:26:56,000 --> 00:26:53,490
right here you can see a couple of Peaks

609
00:26:59,740 --> 00:26:56,010
here and over here you see three peaks

610
00:27:02,420 --> 00:26:59,750
well this is basically a calcite pattern

611
00:27:04,520 --> 00:27:02,430
this was taken aboard ship a few hours

612
00:27:07,490 --> 00:27:04,530
after we collected the sample and this

613
00:27:09,530 --> 00:27:07,500

one on the left was collected at troll

614

00:27:13,010 --> 00:27:09,540

hot springs or I guess you'd call it

615

00:27:16,010 --> 00:27:13,020

warm springs and this line right here

616

00:27:18,320 --> 00:27:16,020

and a few others are indicative of mono

617

00:27:22,190 --> 00:27:18,330

hydrocal site so we were able to find a

618

00:27:24,050 --> 00:27:22,200

an ephemeral phase here that was not

619

00:27:27,980 --> 00:27:24,060

present even when we gotten it in the

620

00:27:29,990 --> 00:27:27,990

boats and got back to the ship second

621

00:27:33,260 --> 00:27:30,000

thing we did up there we had Steve

622

00:27:36,460 --> 00:27:33,270

Squyres along four four four two weeks

623

00:27:38,860 --> 00:27:36,470

of it and we actually ran kind of a mock

624

00:27:42,200 --> 00:27:38,870

mission to Mars kind of a scenario where

625

00:27:45,140 --> 00:27:42,210

Steve Squyres and and the science

626
00:27:47,570 --> 00:27:45,150
operations working group that we defined

627
00:27:49,280 --> 00:27:47,580
state aboard ship and a party when abort

628
00:27:51,590 --> 00:27:49,290
went ashore with the instruments and

629
00:27:54,530 --> 00:27:51,600
what they did is they went to a place

630
00:27:57,830 --> 00:27:54,540
that we'd supposedly never seen took

631
00:28:00,530 --> 00:27:57,840
images the way a rover would take data

632
00:28:04,970 --> 00:28:00,540
the way the instruments would would take

633
00:28:06,350 --> 00:28:04,980
data on MSL and sent that data back to

634
00:28:08,810 --> 00:28:06,360
us and then we were in this little

635
00:28:11,450 --> 00:28:08,820
enclosed room figuring out what to do

636
00:28:13,760 --> 00:28:11,460
next where to go and this shows you some

637
00:28:17,000 --> 00:28:13,770
of the data this is kevin data collected

638
00:28:19,580 --> 00:28:17,010

we decided to go this rock i personally

639

00:28:21,650 --> 00:28:19,590

thought it was a patch of snow so we

640

00:28:25,850 --> 00:28:21,660

called it snowy rock turned out to be

641

00:28:28,130 --> 00:28:25,860

some kind of a granitic nice and when we

642

00:28:29,960 --> 00:28:28,140

went there we analyzed that that's and

643

00:28:33,380 --> 00:28:29,970

so we knew what it was that was pretty

644

00:28:35,090 --> 00:28:33,390

boring stuff Paul Mahaffy decided to

645

00:28:37,240 --> 00:28:35,100

analyze there were actually some lichens

646

00:28:40,820 --> 00:28:37,250

on here so he tried out his Sam

647

00:28:42,920 --> 00:28:40,830

equivalent on the lichens and this

648

00:28:45,400 --> 00:28:42,930

stuff's pretty boring to us so we went

649

00:28:47,680 --> 00:28:45,410

looked at the soil beneath the

650

00:28:49,780 --> 00:28:47,690

smelly rock which shows a lot of

651
00:28:51,910 --> 00:28:49,790
amorphous material and some olivene and

652
00:28:53,560 --> 00:28:51,920
so forth and then we moved on to a

653
00:28:56,380 --> 00:28:53,570
little outcrop that was not too far away

654
00:29:01,030 --> 00:28:56,390
from here and this outcrop actually

655
00:29:03,040 --> 00:29:01,040
contained indications of some hydrosol

656
00:29:06,400 --> 00:29:03,050
alterations so it had some magnesite

657
00:29:08,410 --> 00:29:06,410
presence so we were able to aboard ship

658
00:29:10,360 --> 00:29:08,420
go through the scenario of doing this

659
00:29:12,790 --> 00:29:10,370
with a rover and actually find a place

660
00:29:17,650 --> 00:29:12,800
of interest and go on sample there so

661
00:29:19,870 --> 00:29:17,660
that's that's the story with that that's

662
00:29:21,550 --> 00:29:19,880
out to be a pretty successful campaign

663
00:29:24,040 --> 00:29:21,560

and the next thing we heard Doug Ming

664

00:29:25,900 --> 00:29:24,050

was going to Antarctica so we didn't

665

00:29:29,230 --> 00:29:25,910

want to pass up the opportunity to send

666

00:29:31,390 --> 00:29:29,240

Tara down there so he went I guess with

667

00:29:37,240 --> 00:29:31,400

the Phoenix group down to Antarctica in

668

00:29:39,040 --> 00:29:37,250

January and so here he is actually this

669

00:29:41,370 --> 00:29:39,050

instrument worked in negative 20 degree

670

00:29:43,810 --> 00:29:41,380

weather so it's pretty well ruggedized

671

00:29:46,270 --> 00:29:43,820

he'd really didn't have any standing

672

00:29:47,620 --> 00:29:46,280

orders about what to do so we had to

673

00:29:50,290 --> 00:29:47,630

figure it out for himself but he's

674

00:29:52,390 --> 00:29:50,300

actually a pretty sharp guy so he did a

675

00:29:55,570 --> 00:29:52,400

variety of things one of the things he

676

00:29:57,910 --> 00:29:55,580

did he used mineralogy as an in the

677

00:30:00,520 --> 00:29:57,920

field guide to help out the biologists

678

00:30:01,900 --> 00:30:00,530

there look for nematode populations and

679

00:30:04,420 --> 00:30:01,910

that's not probably the first thing you

680

00:30:06,820 --> 00:30:04,430

think of when you think of quantitative

681

00:30:08,710 --> 00:30:06,830

mineralogy but by tracing the

682

00:30:10,540 --> 00:30:08,720

composition of the soil he was actually

683

00:30:14,920 --> 00:30:10,550

able to point them in the direction of

684

00:30:17,530 --> 00:30:14,930

high nematode populations the second

685

00:30:20,860 --> 00:30:17,540

thing that he did is he was able to map

686

00:30:23,020 --> 00:30:20,870

ancient glacial moraines using using

687

00:30:26,140 --> 00:30:23,030

mineralogy in the way he did this is

688

00:30:29,590 --> 00:30:26,150

that the more recent or more recent

689

00:30:33,040 --> 00:30:29,600

moraines had the sodium sulfate minerals

690

00:30:37,030 --> 00:30:33,050

murabba light and thinner dite and the

691

00:30:39,460 --> 00:30:37,040

more ancient ones had gypsum and calcite

692

00:30:41,260 --> 00:30:39,470

carbonate so by just looking at the

693

00:30:43,930 --> 00:30:41,270

compositions of the phases he could

694

00:30:48,160 --> 00:30:43,940

actually map the edges of these angel a

695

00:30:51,130 --> 00:30:48,170

shelter rains down there Philippe

696

00:30:54,160 --> 00:30:51,140

Saracen took tear up to British Columbia

697

00:30:56,760 --> 00:30:54,170

to the site location for the meridiani

698

00:30:59,620 --> 00:30:56,770

aight discovery and here it is and

699

00:31:02,350 --> 00:30:59,630

basically this is a frozen lake and

700

00:31:03,910 --> 00:31:02,360

these wooden areas like right here these

701
00:31:07,990 --> 00:31:03,920
big log sticking out of here would

702
00:31:10,870 --> 00:31:08,000
actually wick up this this very salty

703
00:31:13,660 --> 00:31:10,880
water and evaporated and the crystals

704
00:31:16,840 --> 00:31:13,670
are found on this wood and and this is

705
00:31:21,670 --> 00:31:16,850
we're ready moretti any height was found

706
00:31:23,500 --> 00:31:21,680
which is a magnesium sulfate 11 with 11

707
00:31:26,950 --> 00:31:23,510
waters it's a very hydrated magnesium

708
00:31:31,000 --> 00:31:26,960
sulfate stable below 2 degrees

709
00:31:33,340 --> 00:31:31,010
centigrade well turns out we didn't find

710
00:31:35,740 --> 00:31:33,350
any more a liteon I'm sorry we didn't

711
00:31:38,080 --> 00:31:35,750
find any riddhi Annie aight it was too

712
00:31:41,980 --> 00:31:38,090
warm that year but this was the

713
00:31:44,050 --> 00:31:41,990

composition of some salts we did find

714

00:31:46,510 --> 00:31:44,060

there and lo and behold when these were

715

00:31:48,970 --> 00:31:46,520

taken back to the lab and analyzed two

716

00:31:52,630 --> 00:31:48,980

weeks later none of this stuff was there

717

00:31:54,610 --> 00:31:52,640

so it's I think it's a big take on

718

00:31:56,650 --> 00:31:54,620

message that the things you collect in

719

00:31:58,480 --> 00:31:56,660

the field may not be the things you

720

00:32:02,890 --> 00:31:58,490

analyze when you bring them back to the

721

00:32:04,920 --> 00:32:02,900

laboratory a month later I went to the

722

00:32:10,450 --> 00:32:04,930

University of Hawaii and I worked with

723

00:32:12,940 --> 00:32:10,460

Jeff Taylor and I'm taking tear over to

724

00:32:15,070 --> 00:32:12,950

the Scarab resolve campaign in November

725

00:32:16,600 --> 00:32:15,080

so I wanted to work with Jeff on just do

726

00:32:19,690 --> 00:32:16,610

a little dry labbing and figure out what

727

00:32:21,100 --> 00:32:19,700

minerals and so forth were present the

728

00:32:23,110 --> 00:32:21,110

first thing Jeff said is well why don't

729

00:32:26,080 --> 00:32:23,120

we try a real lunar sample so he pulled

730

00:32:28,750 --> 00:32:26,090

out a lunar soil sample and we analyzed

731

00:32:31,510 --> 00:32:28,760

it sent it off to one of my co ice Steve

732

00:32:34,060 --> 00:32:31,520

chipra and he sent back a quantitative

733

00:32:37,000 --> 00:32:34,070

analysis and it was just bang on to what

734

00:32:39,640 --> 00:32:37,010

Larry tail Taylor had analyzed by doing

735

00:32:42,640 --> 00:32:39,650

really difficult point counting

736

00:32:45,790 --> 00:32:42,650

techniques ten years earlier so Jeff was

737

00:32:47,560 --> 00:32:45,800

really excited by that so we dropped the

738

00:32:50,080 --> 00:32:47,570

whole project of looking at the Skinner

739

00:32:52,780 --> 00:32:50,090

resolve samples and did nothing but

740

00:32:57,130 --> 00:32:52,790

lunar samples all week so this is a

741

00:33:00,250 --> 00:32:57,140

little graph of a number of samples from

742

00:33:02,800 --> 00:33:00,260

the moon that chemin analyzed versus the

743

00:33:04,540 --> 00:33:02,810

same compositions by point counting you

744

00:33:06,960 --> 00:33:04,550

can see we did a pretty good job with

745

00:33:08,630 --> 00:33:06,970

the exception of a few examples here of

746

00:33:11,300 --> 00:33:08,640

doing the

747

00:33:13,460 --> 00:33:11,310

a same quality of measurement as this

748

00:33:15,050 --> 00:33:13,470

meticulous point counting that literally

749

00:33:17,500 --> 00:33:15,060

took months and months of people's time

750

00:33:20,180 --> 00:33:17,510

on the earth and the chemin instrument

751

00:33:25,220 --> 00:33:20,190

did this in a matter of a couple of

752

00:33:27,230 --> 00:33:25,230

hours for each analysis I came back and

753

00:33:29,960 --> 00:33:27,240

I'd actually talked with we thank jew

754

00:33:31,900 --> 00:33:29,970

whose from the University of Wisconsin I

755

00:33:35,360 --> 00:33:31,910

talked to him at the astrobiology

756

00:33:37,370 --> 00:33:35,370

workshop here rather the the conference

757

00:33:38,780 --> 00:33:37,380

and he asked if he could borrow this

758

00:33:41,510 --> 00:33:38,790

instrument to go on a field trip to

759

00:33:45,530 --> 00:33:41,520

Canada so I said that would be fine so

760

00:33:47,390 --> 00:33:45,540

when I came back I I flew up to Madison

761

00:33:50,300 --> 00:33:47,400

and dropped off the instrument and I

762

00:33:52,910 --> 00:33:50,310

kind of felt like when I left my son off

763

00:33:55,160 --> 00:33:52,920

to his first day of school I got back on

764

00:33:58,430 --> 00:33:55,170

the airplane no instrument no luggage

765

00:34:00,410 --> 00:33:58,440

just got on the plane and left and so we

766

00:34:03,020 --> 00:34:00,420

found we found his students went off

767

00:34:04,460 --> 00:34:03,030

into Canada with this thing and you can

768

00:34:05,960 --> 00:34:04,470

see they went to some very extreme

769

00:34:12,409 --> 00:34:05,970

environments here they were inside a

770

00:34:14,330 --> 00:34:12,419

truckstop bathroom in near sudbury they

771

00:34:20,570 --> 00:34:14,340

needed to recharge the instrument that's

772

00:34:22,550 --> 00:34:20,580

why they went in there anyway so so they

773

00:34:24,590 --> 00:34:22,560

analyzed a whole bunch of samples we've

774

00:34:27,409 --> 00:34:24,600

hang sent me this example of a quarter

775

00:34:29,990 --> 00:34:27,419

green the light thing they got from one

776
00:34:33,110 --> 00:34:30,000
of the banded iron formations and when

777
00:34:36,139 --> 00:34:33,120
they got back to the lab they actually

778
00:34:37,700 --> 00:34:36,149
did some optical microscopy in some tem

779
00:34:41,540 --> 00:34:37,710
and this is actually the Drina light

780
00:34:46,580 --> 00:34:41,550
that was found in the in the xrd from

781
00:34:49,330 --> 00:34:46,590
the field just after that bleep Saracen

782
00:34:52,970 --> 00:34:49,340
took a different terror instrument but

783
00:34:54,800 --> 00:34:52,980
over to Rio Tinto Spain and we've been

784
00:34:58,610 --> 00:34:54,810
over there a couple of times and Rio

785
00:35:00,710 --> 00:34:58,620
Tinto is an ancient mine that has a lot

786
00:35:03,140 --> 00:35:00,720
of iron sulfate sulfides and these are

787
00:35:05,660 --> 00:35:03,150
oxidized to these very interesting iron

788
00:35:08,690 --> 00:35:05,670

sulfate hydrates which we believe are on

789

00:35:12,440 --> 00:35:08,700

Mars some examples of which are on Mars

790

00:35:15,020 --> 00:35:12,450

and a lot of these things are all so

791

00:35:17,510 --> 00:35:15,030

ephemeral so what you what you look at

792

00:35:18,970 --> 00:35:17,520

there may not be in the lab so so we

793

00:35:21,370 --> 00:35:18,980

took a chance and one over there

794

00:35:25,109 --> 00:35:21,380

this is Mark gala numark gallon who's a

795

00:35:28,750 --> 00:35:25,119

French scientist who actually did a

796

00:35:30,670 --> 00:35:28,760

theoretical diagram of the erotica model

797

00:35:32,980 --> 00:35:30,680

of the chemin instrument and actually

798

00:35:35,440 --> 00:35:32,990

came up with a with a ray tracing

799

00:35:37,300 --> 00:35:35,450

simulation so that we change any part of

800

00:35:39,960 --> 00:35:37,310

the instrument and he'll tell us what it

801
00:35:43,270 --> 00:35:39,970
does at the output with with townson and

802
00:35:45,520 --> 00:35:43,280
and range in full with half max of two

803
00:35:47,020 --> 00:35:45,530
theta so I was real happy to see mark in

804
00:35:49,990 --> 00:35:47,030
the field he's just been a just a

805
00:35:51,970 --> 00:35:50,000
mainstay for our program here's an

806
00:35:53,620 --> 00:35:51,980
example of a couple of things we found

807
00:35:56,050 --> 00:35:53,630
out there or Philippe found rather

808
00:35:58,180 --> 00:35:56,060
there's some hydro knee injera site it

809
00:36:02,970 --> 00:35:58,190
was these are just just on the rocks

810
00:36:07,030 --> 00:36:02,980
here from D hydrated salts there's a

811
00:36:11,310 --> 00:36:07,040
example of copia piden coke invite all

812
00:36:14,830 --> 00:36:11,320
so ephemeral mineral on the rocks there

813
00:36:17,770 --> 00:36:14,840

okay so what's next the reason I'm doing

814

00:36:21,220 --> 00:36:17,780

this is I'm interested in offering this

815

00:36:24,190 --> 00:36:21,230

to anyone in the NAI who who cares to do

816

00:36:27,820 --> 00:36:24,200

this kind of a of a field campaign to do

817

00:36:29,650 --> 00:36:27,830

mineralogy and and the cost to anyone

818

00:36:31,180 --> 00:36:29,660

who wants to do it is just the process

819

00:36:33,609 --> 00:36:31,190

of sending it to you and getting it back

820

00:36:37,390 --> 00:36:33,619

as long as you don't drop it from from a

821

00:36:39,820 --> 00:36:37,400

great height and i found the reason i

822

00:36:41,710 --> 00:36:39,830

can i can say this is we found for the

823

00:36:43,900 --> 00:36:41,720

last year that this is a fairly

824

00:36:46,690 --> 00:36:43,910

user-friendly instrument it's very

825

00:36:49,359 --> 00:36:46,700

robust it seems to produce information

826

00:36:52,930 --> 00:36:49,369

that that is valuable from a wide

827

00:36:55,060 --> 00:36:52,940

variety of other disciplines I've

828

00:36:58,330 --> 00:36:55,070

already got it signed up for the rest of

829

00:36:59,770 --> 00:36:58,340

this year to go various places so it's

830

00:37:02,890 --> 00:36:59,780

going just about a different place every

831

00:37:04,390 --> 00:37:02,900

month starting next year though I'll

832

00:37:07,750 --> 00:37:04,400

have two of these things and I'm willing

833

00:37:11,560 --> 00:37:07,760

to work with whoever wants to to take

834

00:37:14,590 --> 00:37:11,570

this in the field so just to conclude

835

00:37:16,000 --> 00:37:14,600

and I hope I have time enough to do a

836

00:37:18,280 --> 00:37:16,010

little demo I actually brought it i'll

837

00:37:22,420 --> 00:37:18,290

show you how you prepare a sample and do

838

00:37:24,520 --> 00:37:22,430

an analysis I think you know Institute

839

00:37:27,520 --> 00:37:24,530

mineralogical analysis is valuable for

840

00:37:29,620 --> 00:37:27,530

astrobiology field campaigns now it's

841

00:37:31,300 --> 00:37:29,630

quite possible for people who aren't

842

00:37:32,860 --> 00:37:31,310

mineralogist to

843

00:37:35,470 --> 00:37:32,870

do mineralogy in the field and i'll show

844

00:37:38,950 --> 00:37:35,480

you how how simple it can be you don't

845

00:37:40,480 --> 00:37:38,960

have to be a mineralogist to do this you

846

00:37:43,600 --> 00:37:40,490

should know a bit something it's more

847

00:37:45,790 --> 00:37:43,610

than a toaster and I think this

848

00:37:47,860 --> 00:37:45,800

real-time in situ mineralogy is a new

849

00:37:49,330 --> 00:37:47,870

concept and I think we don't really know

850

00:37:51,160 --> 00:37:49,340

where it's going to go anytime you do

851
00:37:53,470 --> 00:37:51,170
something new you don't know what all

852
00:37:55,170 --> 00:37:53,480
the applications are going to be I had

853
00:37:59,800 --> 00:37:55,180
no idea we would be able to trace

854
00:38:01,120 --> 00:37:59,810
nematode populations in in Antarctica so

855
00:38:04,330 --> 00:38:01,130
you never know what you're going to find

856
00:38:06,910 --> 00:38:04,340
until you try it so that's it and I

857
00:38:08,980 --> 00:38:06,920
wanted to thank all my various funding

858
00:38:11,530 --> 00:38:08,990
I'd hate to tell you how much money I

859
00:38:13,960 --> 00:38:11,540
spent on this but it was just a ton I'd

860
00:38:16,210 --> 00:38:13,970
like to thank NASA for providing me with

861
00:38:18,400 --> 00:38:16,220
all that money and also to the chemin

862
00:38:21,490 --> 00:38:18,410
team and to institute incorporated which

863
00:38:22,990 --> 00:38:21,500

is philippe Saracens startup company

864

00:38:28,810 --> 00:38:23,000

which has made all this possible so

865

00:38:33,400 --> 00:38:28,820

thanks thank you Dave there is plenty of

866

00:38:35,740 --> 00:38:33,410

time oh so what I suggest is why don't

867

00:38:38,140 --> 00:38:35,750

you go ahead and and get that set up and

868

00:38:40,300 --> 00:38:38,150

if anybody has a question for Dave

869

00:38:42,430 --> 00:38:40,310

during the interim while he's getting

870

00:38:44,530 --> 00:38:42,440

set up this would be a good time to jump

871

00:38:47,260 --> 00:38:44,540

in and you'll have other opportunities

872

00:38:53,520 --> 00:38:47,270

to ask questions as we go along if ever

873

00:39:01,690 --> 00:38:57,070

so here's the instrument about 15

874

00:39:04,590 --> 00:39:01,700

kilograms with batteries and it's got

875

00:39:07,420 --> 00:39:04,600

four hours of life it works off these

876

00:39:11,380 --> 00:39:07,430

laptop batteries and these are

877

00:39:13,120 --> 00:39:11,390

hot-swappable and feel so you can just

878

00:39:15,850 --> 00:39:13,130

take a bunch of batteries and keep

879

00:39:22,210 --> 00:39:15,860

replacing one at a time or you can work

880

00:39:24,790 --> 00:39:22,220

for four hours and and and go home so

881

00:39:29,620 --> 00:39:24,800

let me show you how to to prepare a

882

00:39:32,470 --> 00:39:29,630

sample and load a sample so it's

883

00:39:34,090 --> 00:39:32,480

perfectly safe but you're not going to

884

00:39:36,600 --> 00:39:34,100

be x-rayed by this name or that you'll

885

00:39:39,190 --> 00:39:36,610

be x-rayed by your color television set

886

00:39:42,800 --> 00:39:39,200

the sample goes in there so I'm going to

887

00:39:45,980 --> 00:39:42,810

start start shaking the sample

888

00:39:48,740 --> 00:39:45,990

here okay I'll show you what the sample

889

00:39:52,520 --> 00:39:48,750

consists of it's basically a tuning fork

890

00:39:54,290 --> 00:39:52,530

arrangement and there are two symmetric

891

00:39:57,380 --> 00:39:54,300

sample holders one on each side so you

892

00:39:59,840 --> 00:39:57,390

fill one and not the other and this is

893

00:40:01,730 --> 00:39:59,850

what we call the ashtray so you just you

894

00:40:05,450 --> 00:40:01,740

put it in here at shakes it just as if

895

00:40:06,470 --> 00:40:05,460

it were in the instrument so what I'm

896

00:40:09,710 --> 00:40:06,480

going to do is I'm going to load a

897

00:40:15,920 --> 00:40:09,720

sample and then start it and I'll show

898

00:40:17,660 --> 00:40:15,930

you how to prepare a sample it's not

899

00:40:20,860 --> 00:40:17,670

always as easy assist you don't always

900

00:40:24,140 --> 00:40:20,870

find a bit of your bit of your fireplace

901
00:40:25,610 --> 00:40:24,150
out in the field that so that's what

902
00:40:29,720 --> 00:40:25,620
this is this is a little bit of my

903
00:40:32,690 --> 00:40:29,730
fireplace so this is a 150 micron mesh

904
00:40:33,950 --> 00:40:32,700
screen and all I'm going to do is I'm

905
00:40:48,500 --> 00:40:33,960
going to take this little drumble tool

906
00:40:54,270 --> 00:40:50,849
and I do this in the lab to it's

907
00:40:55,890 --> 00:40:54,280
actually uh it's a very nice way to get

908
00:40:57,930 --> 00:40:55,900
a micro example of something where

909
00:41:01,200 --> 00:40:57,940
you're you're interested in summarizing

910
00:41:02,910 --> 00:41:01,210
enough not other not another horizon so

911
00:41:07,109 --> 00:41:02,920
whatever goes through the screen will

912
00:41:08,370 --> 00:41:07,119
work with Kevin and I don't know if you

913
00:41:10,890 --> 00:41:08,380

can see inside there but there's a

914

00:41:12,390 --> 00:41:10,900

little bit of material in there not too

915

00:41:18,029 --> 00:41:12,400

much but that's certainly not to do the

916

00:41:29,210 --> 00:41:18,039

job so what I'm going to do is I'm going

917

00:41:35,630 --> 00:41:31,790

this material needs to be fairly dry so

918

00:41:37,670 --> 00:41:35,640

that there is an issue with using what

919

00:41:39,550 --> 00:41:37,680

materials they don't really flow into

920

00:41:44,710 --> 00:41:39,560

the cell very well so that's one of the

921

00:41:46,640 --> 00:41:44,720

one of the things we're working on so I

922

00:41:48,560 --> 00:41:46,650

don't know if you can see that but

923

00:41:50,660 --> 00:41:48,570

there's their grains falling in there

924

00:41:54,320 --> 00:41:50,670

and and now they're being shaken around

925

00:41:58,220 --> 00:41:54,330

and filling the filling this this part

926

00:42:01,190 --> 00:41:58,230

right here okay so that's so that

927

00:42:02,720 --> 00:42:01,200

samples ready to go so now what I'm

928

00:42:08,030 --> 00:42:02,730

going to do is I'm just going to drop it

929

00:42:14,480 --> 00:42:08,040

right in here and I'm going to stop

930

00:42:18,109 --> 00:42:14,490

shaking now from here on out this can

931

00:42:21,380 --> 00:42:18,119

either be run by a computer or or by any

932

00:42:23,780 --> 00:42:21,390

kind of web capable device I like to

933

00:42:28,400 --> 00:42:23,790

know I have time I'll show you I can run

934

00:42:29,900 --> 00:42:28,410

it up my Mac iPhone so this is going to

935

00:42:33,650 --> 00:42:29,910

be tough doing this left-handed

936

00:42:35,780 --> 00:42:33,660

backwards let's see okay so this is the

937

00:42:37,670 --> 00:42:35,790

basic there only four commands on the

938

00:42:40,280 --> 00:42:37,680

instrument so it's just that easy to use

939

00:42:42,740 --> 00:42:40,290

it you can't make it has to be that way

940

00:42:44,750 --> 00:42:42,750

or I would have messed it up so this is

941

00:42:47,780 --> 00:42:44,760

the where you run everything from the

942

00:42:52,870 --> 00:42:47,790

status menu dis click this arrow say go

943

00:42:59,640 --> 00:42:52,880

and and you have to give it a name and

944

00:43:09,060 --> 00:43:04,880

I'll say Blake's fireplace okay and

945

00:43:11,700 --> 00:43:09,070

start so here and start going here

946

00:43:15,090 --> 00:43:11,710

pretty soon ok so it's vibrating the

947

00:43:18,810 --> 00:43:15,100

sample and the x-ray beams on is taking

948

00:43:20,670 --> 00:43:18,820

an analysis and the status menu here

949

00:43:21,930 --> 00:43:20,680

tells you exactly what it's doing this

950

00:43:23,670 --> 00:43:21,940

isn't this wouldn't be where you'd want

951
00:43:26,790 --> 00:43:23,680
to look all the time but just to make

952
00:43:30,300 --> 00:43:26,800
sure things are doing okay to look at

953
00:43:35,520 --> 00:43:30,310
the data you go to the data point here

954
00:43:37,470 --> 00:43:35,530
the little data flag and since this is

955
00:43:39,480 --> 00:43:37,480
this is actually talking to a computer

956
00:43:41,220 --> 00:43:39,490
that's running a web interface so you're

957
00:43:44,150 --> 00:43:41,230
actually talking through the computer to

958
00:43:46,380 --> 00:43:44,160
another computer that's running the web

959
00:43:48,480 --> 00:43:46,390
okay there's there's the first pattern

960
00:43:49,680 --> 00:43:48,490
and not I have no idea if you can all

961
00:43:58,410 --> 00:43:49,690
right you know what I can I can hook

962
00:44:03,210 --> 00:43:58,420
that up here I can now turn this to in

963
00:44:20,730 --> 00:44:03,220

my direction Oh which oh ok well I'll

964

00:44:36,039 --> 00:44:23,340

so I close this and open it to make it

965

00:44:41,410 --> 00:44:38,819

okay so basically a pattern is

966

00:44:45,130 --> 00:44:41,420

developing what what this thing does is

967

00:44:47,650 --> 00:44:45,140

every 10 seconds it exposes the CCD well

968

00:44:51,669 --> 00:44:47,660

there we go okay now I get to use my

969

00:44:54,189 --> 00:44:51,679

real laser pointer so basically every

970

00:44:57,130 --> 00:44:54,199

now it's done six exposure so far every

971

00:44:58,799 --> 00:44:57,140

10 seconds it collects another analysis

972

00:45:03,390 --> 00:44:58,809

and sums it into the one you're seeing

973

00:45:06,419 --> 00:45:03,400

now that this does do x-ray fluorescence

974

00:45:15,309 --> 00:45:06,429

and if you want to do x-ray fluorescence

975

00:45:16,870 --> 00:45:15,319

you go to X or up so this shows you the

976
00:45:19,059 --> 00:45:16,880
x-ray fluorescence pattern that's been

977
00:45:22,660 --> 00:45:19,069
generated and what you see is there's

978
00:45:25,719 --> 00:45:22,670
the cobalt of K alpha K beta from the

979
00:45:26,559 --> 00:45:25,729
two there is a little bit of iron in

980
00:45:31,179 --> 00:45:26,569
here I don't know where they aren't

981
00:45:34,120 --> 00:45:31,189
coming from there's calcium maybe I

982
00:45:40,329 --> 00:45:37,120
oh this is going in but you can see the

983
00:45:42,490 --> 00:45:40,339
calcium peak so it gives you an idea you

984
00:45:45,759 --> 00:45:42,500
might be seeing my fireplace is just

985
00:45:49,120 --> 00:45:45,769
made out of calcite can't go back to

986
00:45:50,589 --> 00:45:49,130
x-ray diffraction mode now 11 feature

987
00:45:53,079 --> 00:45:50,599
this is you don't even need to have a

988
00:45:55,960 --> 00:45:53,089

computer to go in the field this thing

989

00:45:59,440 --> 00:45:55,970

will collect everything just from the

990

00:46:01,420 --> 00:45:59,450

front panel and here's a here's

991

00:46:03,999 --> 00:46:01,430

everything that this is every selected

992

00:46:06,579 --> 00:46:04,009

it has a big hard drive on here and so

993

00:46:09,099 --> 00:46:06,589

every pattern has ever been affected by

994

00:46:10,900 --> 00:46:09,109

this instrument is stored every single

995

00:46:13,630 --> 00:46:10,910

image from every pattern so everything

996

00:46:16,539 --> 00:46:13,640

can be re calculated later on if you

997

00:46:23,579 --> 00:46:16,549

ponder some mistake I can go down here

998

00:46:30,209 --> 00:46:26,969

there's the opal CT that I showed you in

999

00:46:34,349 --> 00:46:30,219

my it's the opal CT pattern that i

1000

00:46:36,089 --> 00:46:34,359

showed you that was taken March 22nd so

1001

00:46:37,469 --> 00:46:36,099

all the data is resident in the

1002

00:46:39,150 --> 00:46:37,479

instrument so you don't really have to

1003

00:46:42,589 --> 00:46:39,160

take computer in the field but if you

1004

00:46:46,589 --> 00:46:42,599

want to do analyses in the field you do

1005

00:46:54,000 --> 00:46:46,599

now I can also run this from my from my

1006

00:46:54,010 --> 00:47:02,099

and so if I go to data

1007

00:47:02,109 --> 00:47:08,390

okay so i'm going to change this to xrl

1008

00:47:12,120 --> 00:47:10,470

well this is kind of a part of it I

1009

00:47:16,799 --> 00:47:12,130

really want to show you the real deal

1010

00:47:19,890 --> 00:47:16,809

okay so here's it so here's the xrd

1011

00:47:22,140 --> 00:47:19,900

pattern now this is a perfectly a

1012

00:47:25,890 --> 00:47:22,150

pattern analyzed right now so let's why

1013

00:47:29,400 --> 00:47:25,900

don't we do that mean so yes this is a

1014

00:47:32,460 --> 00:47:29,410

weak point with consoling a we we cannot

1015

00:47:36,509 --> 00:47:32,470

see you we try all kinds of a method and

1016

00:47:38,970 --> 00:47:36,519

no child too okay actually need a

1017

00:47:41,640 --> 00:47:38,980

question for you Dave okay I'm tones are

1018

00:47:45,269 --> 00:47:41,650

going to take the mark the Mars machine

1019

00:47:50,269 --> 00:47:45,279

to do this to load a sample and I'm not

1020

00:47:54,269 --> 00:47:50,279

it good question a lot slower than this

1021

00:47:57,029 --> 00:47:54,279

basically the 11 MSL gets to an outcrop

1022

00:47:59,130 --> 00:47:57,039

it's probably going to be six days to a

1023

00:48:02,549 --> 00:47:59,140

week to do a full workup if everything

1024

00:48:05,130 --> 00:48:02,559

works fine and for it will go through

1025

00:48:07,979 --> 00:48:05,140

all the remote sensing the contact

1026

00:48:09,660 --> 00:48:07,989

instrument stuff there will be you know

1027

00:48:12,809 --> 00:48:09,670

ground in the loop to figure out what to

1028

00:48:15,450 --> 00:48:12,819

do next will decide to collect a sample

1029

00:48:18,720 --> 00:48:15,460

or not that sample is collected by the

1030

00:48:20,099 --> 00:48:18,730

drill the news the new drill is actually

1031

00:48:23,460 --> 00:48:20,109

a percussion drill there's no pressure

1032

00:48:26,249 --> 00:48:23,470

on MSL now so it thrills and crushes a

1033

00:48:31,079 --> 00:48:26,259

sample it's sieve and then that sample

1034

00:48:32,819 --> 00:48:31,089

is delivered to Kevin and Sam and that

1035

00:48:35,099 --> 00:48:32,829

whole process will probably take four or

1036

00:48:38,220 --> 00:48:35,109

five or maybe six days and on the last

1037

00:48:41,309 --> 00:48:38,230

day or two then Sam where Kevin will do

1038

00:48:42,970 --> 00:48:41,319

an analysis we analyzed at night because

1039

00:48:46,300 --> 00:48:42,980

it's colder and that's what we

1040

00:48:49,120 --> 00:48:46,310

like to have we expect that we may take

1041

00:48:51,730 --> 00:48:49,130

as long as 10 hours to do a single

1042

00:48:54,550 --> 00:48:51,740

analysis depending on how complex the

1043

00:48:55,870 --> 00:48:54,560

material is for obvious reasons we

1044

00:48:58,000 --> 00:48:55,880

wanted to make this thing a lot faster

1045

00:48:59,950 --> 00:48:58,010

than MSL because you don't want to sit

1046

00:49:02,530 --> 00:48:59,960

there for two days waiting for the

1047

00:49:05,980 --> 00:49:02,540

result so this is about I would say 20

1048

00:49:09,700 --> 00:49:05,990

time 25 times faster to that enough msl

1049

00:49:12,580 --> 00:49:09,710

is so yeah I'll take a probably to two

1050

00:49:15,040 --> 00:49:12,590

nights of data and and that'll give us

1051
00:49:18,910 --> 00:49:15,050
what we're seeing here you go in about

1052
00:49:21,670 --> 00:49:18,920
two or three hours with dave is there

1053
00:49:24,040 --> 00:49:21,680
anything that we've learned about the

1054
00:49:28,840 --> 00:49:24,050
properties of the soil from mars phoenix

1055
00:49:31,240 --> 00:49:28,850
that leads you to consider any changes

1056
00:49:33,820 --> 00:49:31,250
or any aspects of the way you're

1057
00:49:37,359 --> 00:49:33,830
requiring a sample and getting it in the

1058
00:49:39,490 --> 00:49:37,369
instrument on MSL um a lot of that stuff

1059
00:49:41,710 --> 00:49:39,500
yeah good yeah that's that's a great

1060
00:49:44,710 --> 00:49:41,720
question we're really thinking a lot

1061
00:49:46,750 --> 00:49:44,720
about that now well Doug man who's on my

1062
00:49:49,359 --> 00:49:46,760
team it's also one of the Phoenix guys

1063
00:49:51,010 --> 00:49:49,369

so and he's a soil scientist so we're

1064

00:49:54,730 --> 00:49:51,020

we're puzzling over some of those

1065

00:49:58,510 --> 00:49:54,740

results my first answer is let Sam try

1066

00:50:02,260 --> 00:49:58,520

it first then we'll do it and the thing

1067

00:50:04,240 --> 00:50:02,270

that I'm mostly worried about is some of

1068

00:50:06,220 --> 00:50:04,250

my other co eyes day vanaman Dave fish

1069

00:50:08,170 --> 00:50:06,230

and Steve chipra have done a lot of work

1070

00:50:11,380 --> 00:50:08,180

on iron sulfate hydrates and these

1071

00:50:13,480 --> 00:50:11,390

things are real nasty things some of

1072

00:50:15,130 --> 00:50:13,490

these things can can when you warm them

1073

00:50:17,950 --> 00:50:15,140

up they'll go through a liquid phase

1074

00:50:20,410 --> 00:50:17,960

make a slurry and then lose water and

1075

00:50:21,820 --> 00:50:20,420

turn into cement so we certainly don't

1076

00:50:26,599 --> 00:50:21,830

want that in our funnel when we're

1077

00:50:31,700 --> 00:50:28,729

what I would like to do is have a wait

1078

00:50:34,700 --> 00:50:31,710

and see thing to just watch the property

1079

00:50:37,099 --> 00:50:34,710

stuff before we do anything I know you

1080

00:50:39,680 --> 00:50:37,109

know Sam wants to and so do i want to

1081

00:50:41,660 --> 00:50:39,690

see exactly what's there but I want to

1082

00:50:43,970 --> 00:50:41,670

be a little cautious in the beginning to

1083

00:50:45,559 --> 00:50:43,980

make sure we don't force them cemented

1084

00:50:52,729 --> 00:50:45,569

in our funnel one that will be the end

1085

00:50:54,410 --> 00:50:52,739

of it okay any more questions or okay

1086

00:50:56,870 --> 00:50:54,420

i'll show you how we how we analyze this

1087

00:50:58,970 --> 00:50:56,880

there's so you see there's a there's a

1088

00:51:01,509 --> 00:50:58,980

very nice pretty nice diffraction

1089

00:51:06,349 --> 00:51:01,519

pattern developing so i'm going to go to

1090

00:51:08,380 --> 00:51:06,359

files and i'm going to download one of

1091

00:51:11,960 --> 00:51:08,390

these patterns so i'm going to download

1092

00:51:13,489 --> 00:51:11,970

the k alpha pattern right here and what

1093

00:51:15,589 --> 00:51:13,499

I'm doing right now is I'm taking it off

1094

00:51:17,269 --> 00:51:15,599

the computer on the instrument and

1095

00:51:22,940 --> 00:51:17,279

bringing it on to the computer that's

1096

00:51:25,039 --> 00:51:22,950

onto this computer okay and I brought

1097

00:51:26,839 --> 00:51:25,049

down a format which is compatible with a

1098

00:51:30,079 --> 00:51:26,849

commercial program which I have on this

1099

00:51:33,200 --> 00:51:30,089

machine so so here we go we're opening

1100

00:51:36,620 --> 00:51:33,210

up this materials data J program there's

1101

00:51:39,920 --> 00:51:36,630

the very same pattern in Jade i also

1102

00:51:41,390 --> 00:51:39,930

have and i'll have the j program which

1103

00:51:43,880 --> 00:51:41,400

is a search match and quantitative

1104

00:51:46,489 --> 00:51:43,890

analysis program but also I have the I

1105

00:51:48,259 --> 00:51:46,499

CBD powder file which is which is the

1106

00:51:49,870 --> 00:51:48,269

powder complete powder file of all the

1107

00:51:52,609 --> 00:51:49,880

minerals that are that are known

1108

00:51:56,720 --> 00:51:52,619

resident on the machine so the first

1109

00:51:59,059 --> 00:51:56,730

thing I would do is go to search match

1110

00:52:01,819 --> 00:51:59,069

and say I want to look in the minerals

1111

00:52:08,630 --> 00:52:01,829

files to see what this is until it to go

1112

00:52:09,710 --> 00:52:08,640

and it asked me a few questions and well

1113

00:52:14,960 --> 00:52:09,720

there you go looks like Blake's

1114

00:52:18,499 --> 00:52:14,970

fireplace it's calcite so that was kind

1115

00:52:21,229 --> 00:52:18,509

of a trivial example but it'll do the

1116

00:52:22,940 --> 00:52:21,239

same with complex things I wanted to

1117

00:52:29,479 --> 00:52:22,950

give myself something easy so I didn't

1118

00:52:32,720 --> 00:52:29,489

screw it up question yes this is John it

1119

00:52:35,509 --> 00:52:32,730

aims it's a great instrument have you

1120

00:52:37,700 --> 00:52:35,519

thought about missions beyond MSL for

1121

00:52:39,440 --> 00:52:37,710

example sending it on some small

1122

00:52:42,440 --> 00:52:39,450

spacecraft to go and check out some of

1123

00:52:46,460 --> 00:52:42,450

the near-earth asteroids absolutely

1124

00:52:48,019 --> 00:52:46,470

we're actually working on yeah that one

1125

00:52:52,819 --> 00:52:48,029

thing we have to do is make it smaller

1126
00:52:55,609 --> 00:52:52,829
and we actually are building a shoebox

1127
00:52:57,049 --> 00:52:55,619
sized instrument now and which we're

1128
00:53:00,759 --> 00:52:57,059
going to take down the scare of resolve

1129
00:53:03,019 --> 00:53:00,769
campaign and it literally is it's about

1130
00:53:05,120 --> 00:53:03,029
it's half the size of this so we're

1131
00:53:08,150 --> 00:53:05,130
getting down to something we think can

1132
00:53:11,210 --> 00:53:08,160
be run on smaller missions we're

1133
00:53:13,940 --> 00:53:11,220
shooting for five kilograms about

1134
00:53:16,400 --> 00:53:13,950
shoebox-sized and that includes an

1135
00:53:18,559 --> 00:53:16,410
automatic sample delivery system so the

1136
00:53:21,589 --> 00:53:18,569
you poor crushed material in there it'll

1137
00:53:23,809 --> 00:53:21,599
it'll sort it into the left plus 150

1138
00:53:26,059 --> 00:53:23,819

micron material and deliver that to the

1139

00:53:28,460 --> 00:53:26,069

sample holder so we're we have that

1140

00:53:30,940 --> 00:53:28,470

design we're building it and actually

1141

00:53:34,249 --> 00:53:30,950

have a couple proposals in right now to

1142

00:53:36,859 --> 00:53:34,259

do something like that but yeah I'm

1143

00:53:38,809 --> 00:53:36,869

hopeful we can go to this is just a

1144

00:53:42,410 --> 00:53:38,819

general purpose instrumented it's been

1145

00:53:44,420 --> 00:53:42,420

proposed for a variety places already my

1146

00:53:46,279 --> 00:53:44,430

first proposal was pretty much paper

1147

00:53:48,220 --> 00:53:46,289

where that was funny they did the old

1148

00:53:50,500 --> 00:53:48,230

sham wholly-owned for the

1149

00:53:53,590 --> 00:53:50,510

was that a mission I proposed this in

1150

00:53:54,880 --> 00:53:53,600

1992 with barely more than a napkin

1151

00:53:57,040 --> 00:53:54,890

drawing they were lucky they didn't

1152

00:54:05,680 --> 00:53:57,050

choose me but yeah I've been trying

1153

00:54:08,080 --> 00:54:05,690

variety things I heard it which is a

1154

00:54:10,510 --> 00:54:08,090

walk-in able to really my need to

1155

00:54:13,710 --> 00:54:10,520

exercise on my family man instantly

1156

00:54:19,510 --> 00:54:13,720

something that's under tension is

1157

00:54:22,150 --> 00:54:19,520

building her basically that the

1158

00:54:24,810 --> 00:54:22,160

beginning of it was a dang I wish I had

1159

00:54:29,320 --> 00:54:24,820

brought this you know I figured this out

1160

00:54:31,359 --> 00:54:29,330

when I was a postdoc and I used to go

1161

00:54:33,400 --> 00:54:31,369

use his carbon code or over in another

1162

00:54:36,240 --> 00:54:33,410

building and there were all these gave I

1163

00:54:39,460 --> 00:54:36,250

think repeating the question I I see

1164

00:54:42,310 --> 00:54:39,470

somebody but rachel is what concert it

1165

00:54:44,260 --> 00:54:42,320

was what kinds of technologies were were

1166

00:54:48,460 --> 00:54:44,270

useful or were necessary to make this

1167

00:54:50,710 --> 00:54:48,470

small okay yeah I came up with this idea

1168

00:54:52,270 --> 00:54:50,720

when I was a postdoc at Ames and I and I

1169

00:54:54,880 --> 00:54:52,280

was running rummaging through a bunch of

1170

00:54:57,520 --> 00:54:54,890

drawers of stuff and I found this little

1171

00:55:00,970 --> 00:54:57,530

x-ray camera from the 40s to film

1172

00:55:03,580 --> 00:55:00,980

cameras called a micro focus camera and

1173

00:55:06,520 --> 00:55:03,590

it's about the size of a large orange

1174

00:55:08,230 --> 00:55:06,530

and so that was my goal to make

1175

00:55:12,580 --> 00:55:08,240

something electronic that would be that

1176
00:55:14,770 --> 00:55:12,590
side so the first component we worked on

1177
00:55:16,990 --> 00:55:14,780
was the camera and the camera we got

1178
00:55:20,500 --> 00:55:17,000
down to about this size not in cap not

1179
00:55:24,400 --> 00:55:20,510
counted electronics the real issue was

1180
00:55:28,120 --> 00:55:24,410
the x-ray tube and power supplies are

1181
00:55:30,609 --> 00:55:28,130
just a tough business and so we now have

1182
00:55:32,440 --> 00:55:30,619
power supplies that we didn't we didn't

1183
00:55:35,020 --> 00:55:32,450
make that they were made by a commercial

1184
00:55:38,140 --> 00:55:35,030
like oxford instruments that are all

1185
00:55:40,300 --> 00:55:38,150
about this size way about half a

1186
00:55:42,849 --> 00:55:40,310
kilogram so we're getting much better in

1187
00:55:44,530 --> 00:55:42,859
that regard and i would say mostly you

1188
00:55:47,200 --> 00:55:44,540

know once we get the geometry which is a

1189

00:55:49,990 --> 00:55:47,210

which is the compact geometry we needed

1190

00:55:52,290 --> 00:55:50,000

to make the cameras small and then make

1191

00:55:54,670 --> 00:55:52,300

the x-ray too small a power supply so

1192

00:55:58,150 --> 00:55:54,680

we're obviously getting going in the

1193

00:55:59,859 --> 00:55:58,160

right direction i'm hoping to get it

1194

00:56:01,810 --> 00:55:59,869

smaller than five kilograms i don't know

1195

00:56:04,750 --> 00:56:01,820

if we're going to get there certainly a

1196

00:56:12,190 --> 00:56:04,760

little bit but not one not two but

1197

00:56:19,559 --> 00:56:12,200

maybe three are there any other

1198

00:56:28,079 --> 00:56:21,660

well if not let's thank our speaker

1199

00:56:31,819 --> 00:56:28,089

again reminder of index director seven

1200

00:56:35,069 --> 00:56:31,829

RPG at the end of September will be on

1201

00:56:36,959 --> 00:56:35,079

September 29th and it will be norm sleep

1202

00:56:39,870 --> 00:56:36,969

telling us about the habitability of

1203

00:56:41,670 --> 00:56:39,880

super Earths so thanks everybody and