The Application of Hand Held Laser Induced Breakdown Spectroscopy to Lithium Exploration: A Case Study

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Overview

- **The LIBS analytical technique: Laser Induced Breakdown Spectroscopy or LIBS-What is it and what can it do?**

- **Application of LIBS to understanding elemental abundance and in geological samples**

- **Example of using Hand Held LIBS to drilling samples:**
  - **Elemental analysis of Li in field pressed particulate samples from the Agua Fria Exploration Project, Sonora, Mexico**

- **Observations, Comments and Conclusions**

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Laser Induced Break down Spectroscopy or LIBS-What is it and what can it do?

- LIBS (Laser Induced Breakdown Spectroscopy)
  - Bench top technology for the past 50 years or so
  - Optical

- Advantages include:
  - Light Elements e.g. Li, Be, B, C, Na
  - Wide element range possible but dependent on spectral range of system used
  - Fast!
  - Spatially Precise

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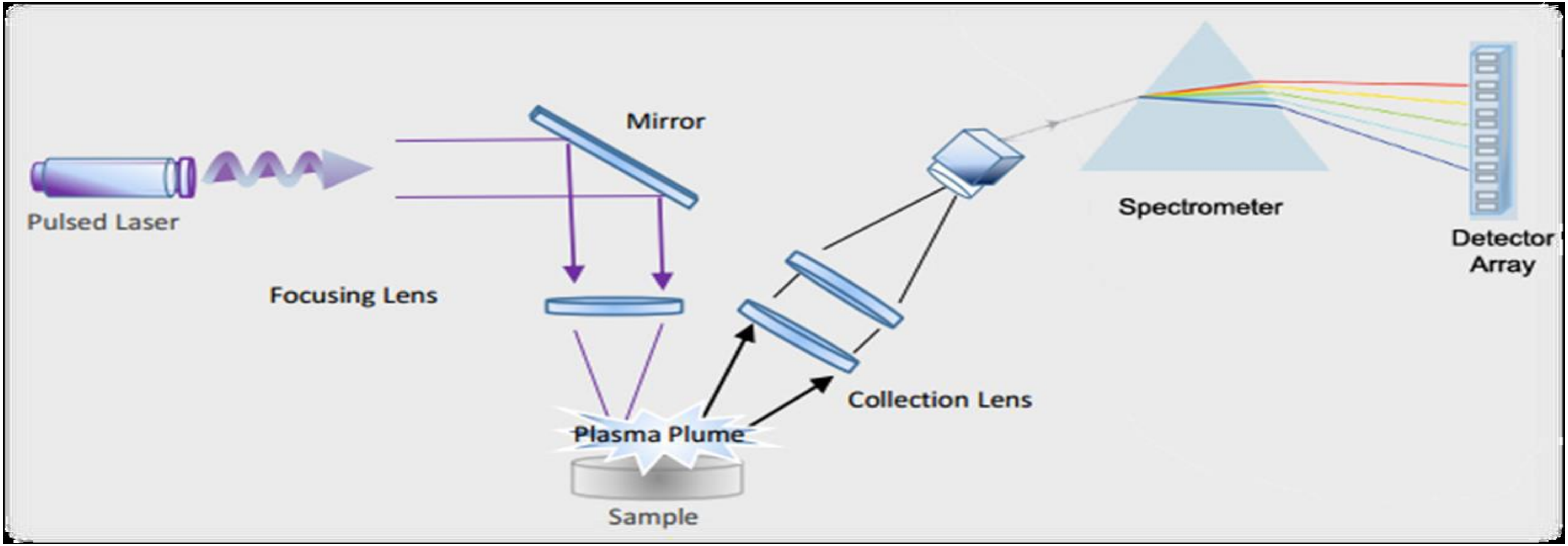
Handheld LIBS [HHLIBS]

- **Handheld LIBS [HHLIBS] is a recent development in the technology that is evolving quickly**
- **Early users of HHLIBS have been challenged by:**
  - **Matrix specificity of empirical calibrations**
  - **Reliance on sample preparation for particulate samples when compared to other field portable analytical tools such as field portable XRF [fpXRF]**
  - **Weaker performance on key elements for geochemically important elements such as As, Bi, W, Cl etc..**
- **New advancements in both hardware and software are addressing some these issues**

Laser Induced Breakdown Spectroscopy (LIBS)

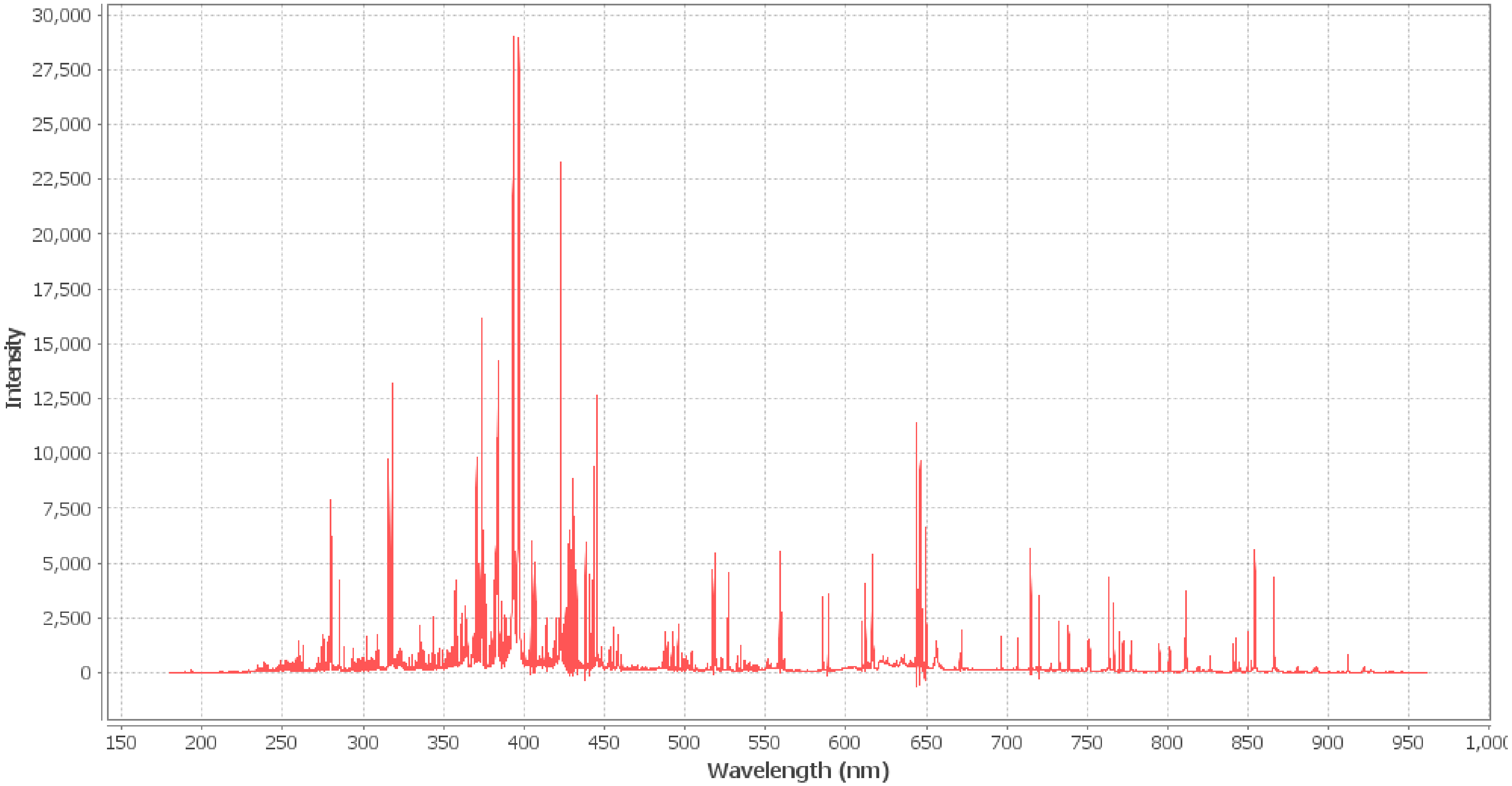


- **Atomic Emission Spectroscopy-Similar to other Optical Emission techniques but utilizes a laser to excite sample**
- **Can measure any sample medium (powder, solid, liquid, nonconductive)**

Rapid Evolution of Technology

- **Hand held LIBS analysers have seen rapid developments to:**
  - **Improve laser quality and pulse consistency**
  - **Increase spectral range**
  - **Improve optics and therefore signal quality**
  - **Reduce size, weight and ergonomics**
  - **Provide software based calibration tools**

LIBS Spectra SciAps Z300 190-950nm



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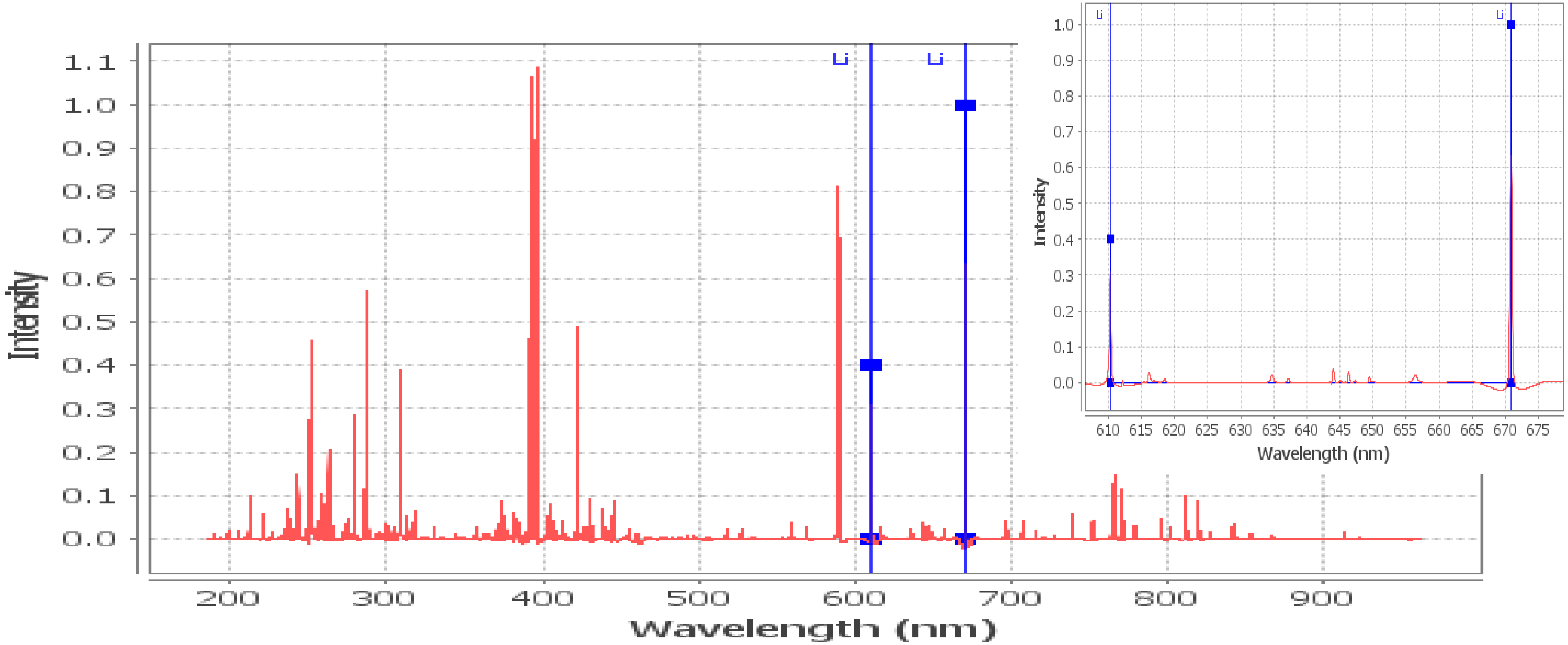
Laser Induced Break down Spectroscopy or LIBS-What is it and what can it do?



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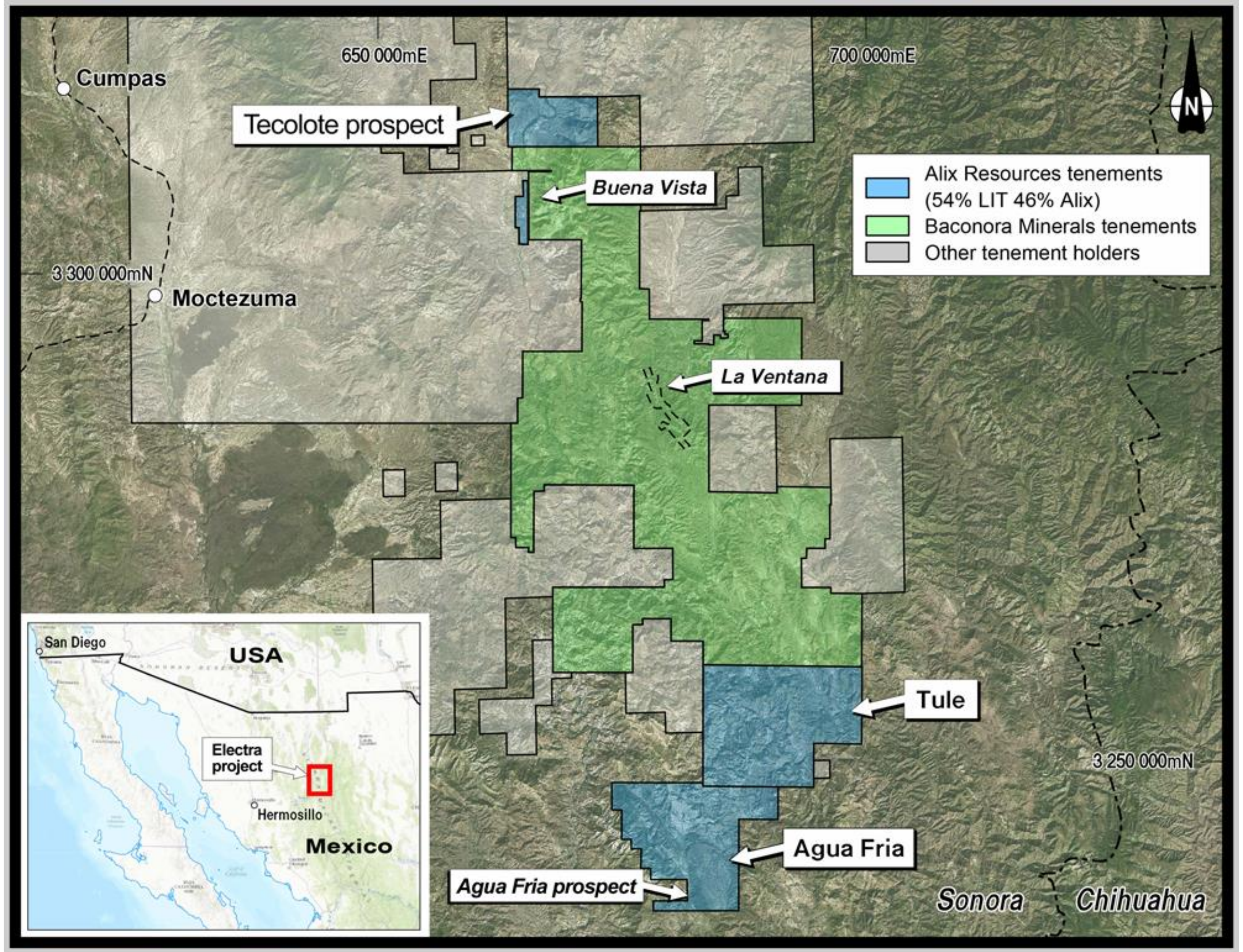
Application of LIBS to characterising geological samples

- LIBS has been used extensively to test geological materials: GEOLIBS-Application of LIBS to the analysis of geological and environmental materials. Harmon, Russo and Hark (2013)
- All element respond between 190-900nm but have variable sensitivities: spectral range is very important for testing geological materials
- Laser spot size on different LIBS can vary from microns to hundreds of microns-related to ability to resolve samples with different grain sizes.
- Laser wavelength and power relate to data quality
- Use of purge gases such as Argon and Helium can improve data

Case Study

Li bearing Hectorite clay RAB drilling program: Elemental analysis of Li in field pressed particulate samples from the Agua Fria Exploration Project, Sonora, Mexico



Source https://lithium-au.com/electra-project/

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Sampling methodology

- 3m RAB composites were split and sub samples pressed using Reflex-PRESS field portable sample press
- Samples tested in 3 different locations using purpose built empirical calibration: Approximate test time <3sec/test
- Data compared to conventional 4 Acid digest with ICP finish

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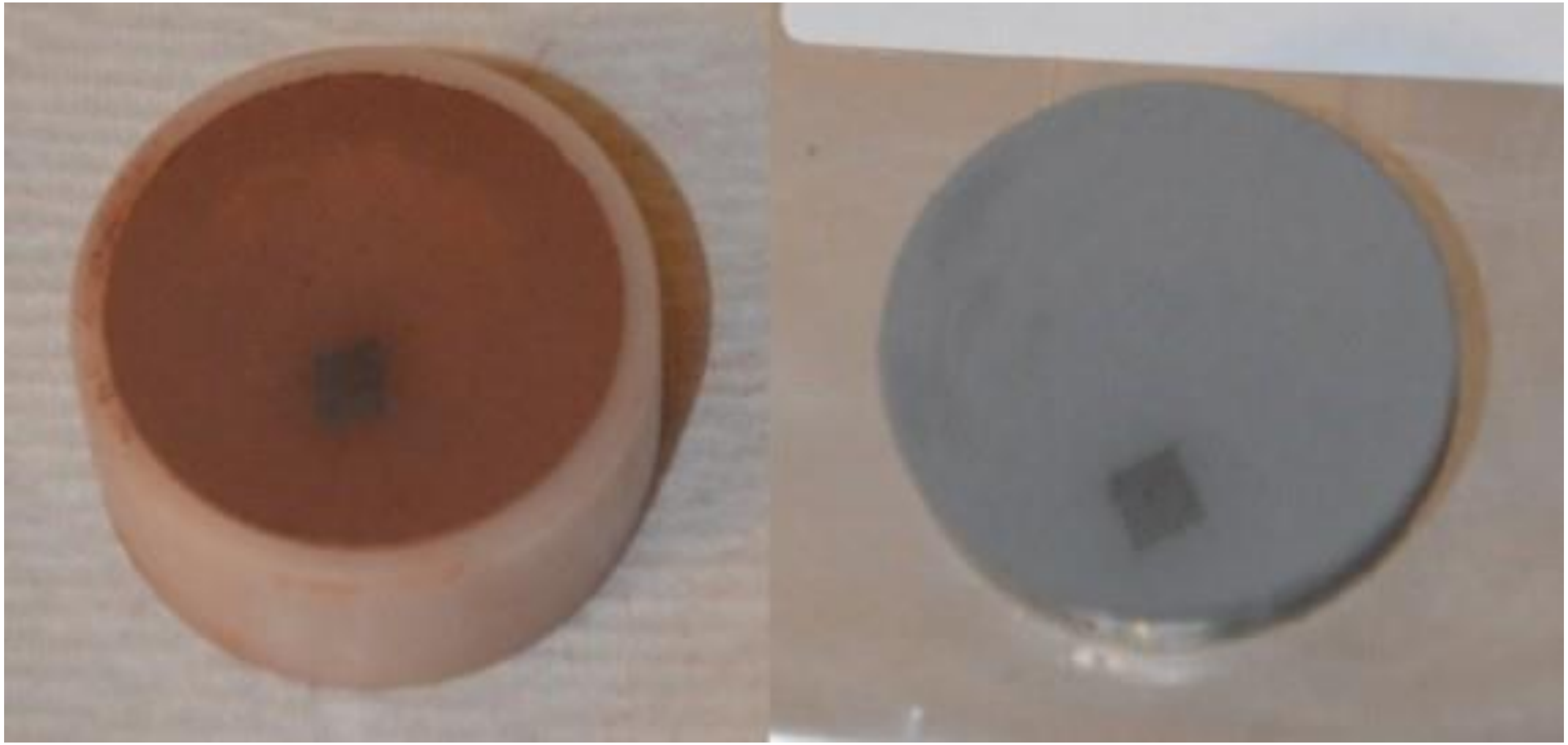
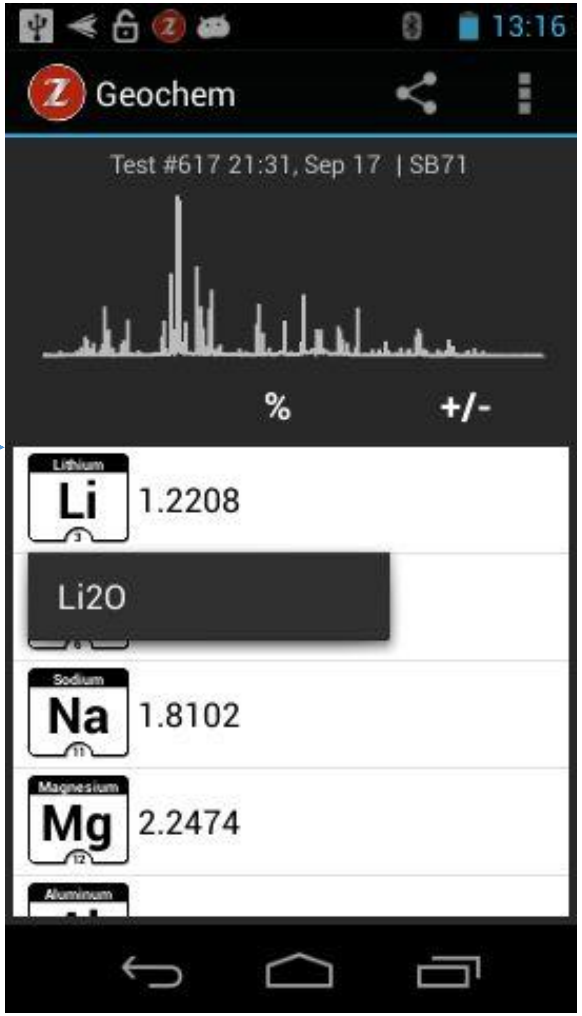
Sample preparation

Sample preparation



http://detcrc.com.au/top-ten/libs-sample-preparation-finalised-lab-rig-applications/

Data Collection



Time	Test #	Name	Li (%)	Li +/- (%)
30/04/2017 16:07	3034	Test #3034 16:07, Apr 30	0.09027	0.007598
30/04/2017 16:07	3035	Test #3035 16:07, Apr 30	0.02736	0.002912
30/04/2017 16:07	3036	Test #3036 16:07, Apr 30	0.04906	0.003895
30/04/2017 16:08	3037	Test #3037 16:08, Apr 30	0.08872	0.007708
30/04/2017 16:08	3038	Test #3038 16:08, Apr 30	0.08345	0.009176
30/04/2017 16:08	3039	Test #3039 16:08, Apr 30	0.07996	0.00755
30/04/2017 16:08	3040	Test #3040 16:08, Apr 30	0.1006	0.008805
30/04/2017 16:08	3041	Test #3041 16:08, Apr 30	0.02547	0.002376
30/04/2017 16:09	3042	Test #3042 16:09, Apr 30	0.002424	0.001676
30/04/2017 16:09	3043	Test #3043 16:09, Apr 30	0.05239	0.00652
30/04/2017 16:09	3044	Test #3044 16:09, Apr 30	0.0259	0.002828
30/04/2017 16:09	3045	Test #3045 16:09, Apr 30	0.08666	0.004409
30/04/2017 16:10	3046	Test #3046 16:10, Apr 30	0.005871	0.002204
30/04/2017 16:11	3047	Test #3047 16:11, Apr 30	0.05091	0.004383
30/04/2017 16:11	3048	Test #3048 16:11, Apr 30	0.04595	0.002678
30/04/2017 16:11	3049	Test #3049 16:11, Apr 30	0.04861	0.004347
30/04/2017 16:11	3050	Test #3050 16:11, Apr 30	0.03947	0.005308
30/04/2017 16:11	3051	Test #3051 16:11, Apr 30	0.04193	0.006799
30/04/2017 16:12	3052	Test #3052 16:12, Apr 30	0.03426	0.003115

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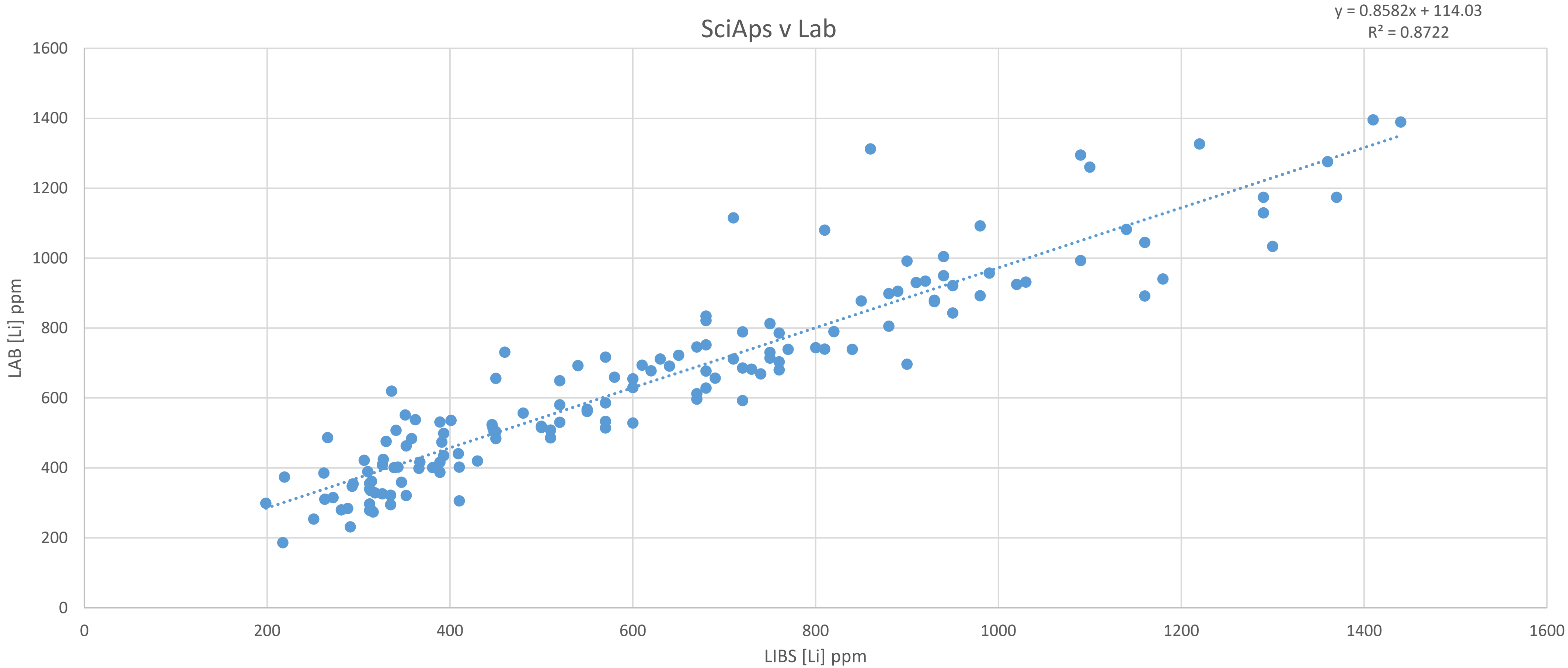
Comparative performance with laboratory n=148 over 4 drillholes



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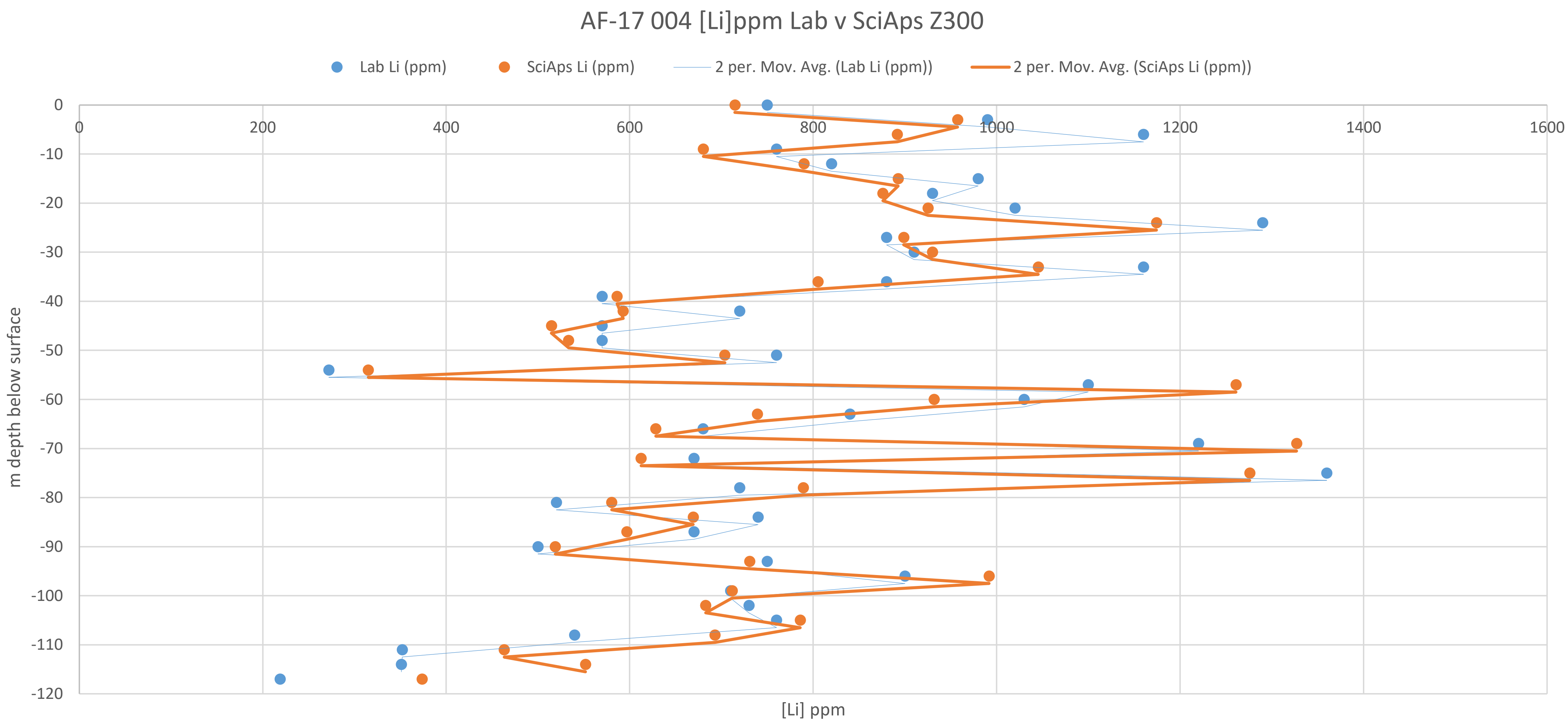
Comparative performance with laboratory



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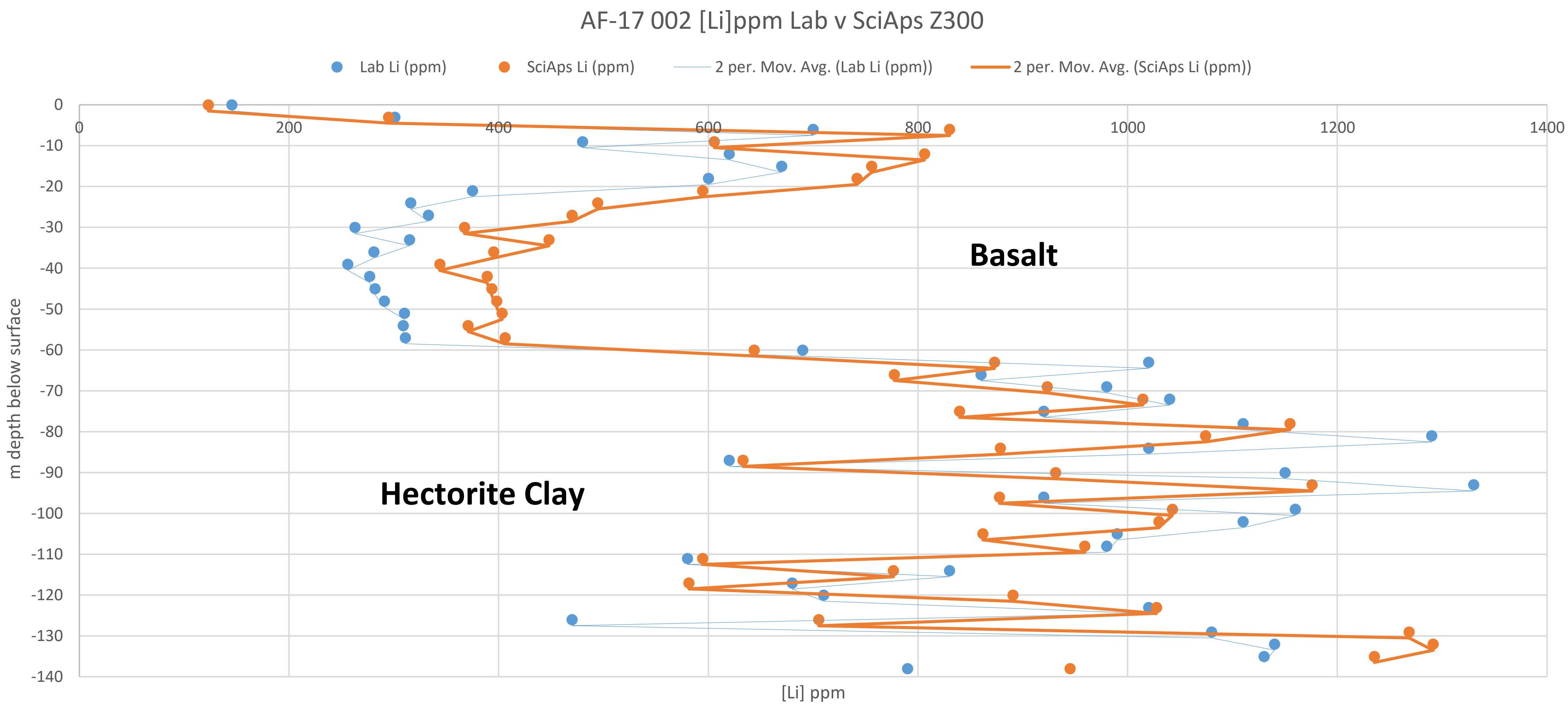
Comparative performance with laboratory



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Observations

For best results:

- **Samples should be flat**
- **Samples should be dry**
- **Samples should be well consolidated**
- **Quantitative analysis currently required careful set-up of empirical calibrations**
- **Using the SciAps Z300 measurement area is highly targeted and only measures 2mmX2mm max area per test**
- **Changes in lithology and associated matrix variations can affect performance of empirical calibration**

Conclusions

- HHLIBS can provide valuable data in a field or lab setting to compliment conventional analytical and microanalytical techniques on a range of industry standard drilling sample types

- Relatively simple sample preparation and speed of analysis allows high throughput for drilling samples in the field.

- Direct in field measurement of elements such as Li that are current not possible with conventional techniques has been demonstrated to be possible

Thank You!

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