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Prolific Stone International Pty Ltd
4/159 Canterbury Road
Kilsyth VIC 3137

Attention: Mr. Simon Heyblok

9 December 2021

# TILIQUA BLUESTONE
## Comparison to CoM Specifications

**Client Reference:** Request S. Heyblok

**Our Reference:** PSI1121-1A

**Investigating Officer(s):** Mark Milevski

**Report Prepared By:** Mark Milevski

James P Mann
Laboratory Manager

| | Draft | Reviewed | Released |
|---|---|---|---|
| Name | MM | TB | MM |
| Date | 25/11/21 | 1/12/21 | 9/12/21 |

## 1. INTRODUCTION

Stone Initiatives received a request from the client's representative to evaluate a sample of basalt (bluestone). The sample supplied was identified as follows:

- Tiliqua Bluestone (our reference: B342)

## 2. EVALUATION

The aim of the investigation was to carry out an evaluation of the basic physical properties of the stone. The tests carried out were:

- Water Absorption / Bulk Specific Gravity
- Flexural Strength
- Unconfined Compressive Strength
- Abrasion Resistance
- Slip Resistance
- Petrographic Analysis / Determination of Secondary Mineral Content

Water absorption and bulk specific gravity were determined on the samples supplied in accordance with ASTM C97-18 "Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone". The specimens had been dried at 60 ± 2°C for 48 hours followed by soaking at 22 ± 2°C for a further 48 hours.

The flexural strength of each specimen was determined in accordance with ASTM C880M-18 "Standard Test Method for Flexural Strength of Dimension Stone". The dry specimens had been dried at 60±2˚C for 48 hours prior to testing. The soaked specimens had been immersed in water for 48 hours at 22±2˚C. Testing was carried out with the load applied perpendicular to the wearing face with the sawn face in tension.

The compressive strength of each specimen was determined in accordance with ASTM C170M-17 "Standard Test Method for Compressive Strength of Dimension Stone". The dry specimens had been dried at 60±2˚C for 48 hours prior to testing. The soaked specimens had been immersed in water for 48 hours at 22±2˚C.

Index of Abrasion Resistance was determined in accordance with ASTM C1353M-20 "Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser". Three representative specimens were subjected to 1000 cycles using H-22 wheels with a 1kg load.

Slip resistance was determined in accordance with Appendix A of AS 4586:2013 "Slip resistance classification of new pedestrian surface materials". Testing was carried out on the honed finish at five separate sites in a wet condition using a British Pendulum fitted with a Slider 96 (4S) rubber slider[1].

Secondary mineral content of the sample was determined in accordance with AS 1141.26 "Method 26: Secondary minerals content in basic igneous rocks". Three representative thin sections of approximately 30-micron thickness were taken from the sample and examined under a polarizing light microscope.

[1] Slider expiry date: 22 March 2022

## 3. RESULTS

Results are summarised in the table below. Full test data are detailed in Appendix A of this report.

| Property | Tiliqua Sawn Bluestone<br>Mean (range) |
|---|---|
| **Bulk Specific Gravity**<br>• (kg.m$^{-3}$) | 2619 (2582 – 2648) |
| **Water Absorption**<br>• (% by weight) | 1.8 (1.7 – 2.1) |
| **Flexural Strength**<br>• Dried (MPa)<br>• Soaked (MPa) | <br>16.9 (15.8 – 19.6)<br>17.6 (14.1 – 24.0) |
| **Compressive Strength**<br>• Dried (MPa)<br>• Soaked (MPa) | <br>162 (148 – 174)<br>144 (129 – 158) |
| **Abrasion Resistance**<br>• Index of Abrasion (Ha) | <br>40 (34 – 47) |
| **Slip Resistance**<br>• Slip Resistance Value<br>• Classification | <br>67<br>P5 |
| **Secondary Mineral Content**<br>• SMC (%) | <br>1.1 |

## 4. SLIP RESISTANCE

Results are summarised in the table below. Full test data are detailed in Appendix A of this report.

| Property | Tiliqua Sawn Basalt<br>Sawn / Rubbed |
|---|---|
| **Slip Resistance AS 4586:2013**<br>– Classification<br>– Slip Resistance Value (SRV) | <br>P5<br>67 (BPN 66 – 70) |

### 4.1. Discussion

The Tiliqua Bluestone with a sawn / rubbed finish achieved an SRV of 67 attaining a P5 classification (SRV > 54). According to Table 3B of the Standards Australia handbook HB198-2014[2] the surface finish is suitable for locations that include the following[3]:

- External walkways including ramps, sloping driveways, footpaths etc., including those steeper than 1 in 14
- Loading docks undercover and commercial kitchens
- Swimming pool ramps and stairs leading to water

[2] Guide to the specification and testing of slip resistance of pedestrian surfaces
[3] 5.2 of HB198 states: "The use of these values should be in the context of design, which also considers abnormal wear, maintenance, abnormal contamination, the presence (or otherwise) of water or other lubricants, the nature of the pedestrian traffic (including age, gait and crowding), the footwear (or lack thereof), slope lighting and handrails."

# Appendix A
# Test Certificates

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# WATER ABSORPTION, BULK SPECIFIC GRAVITY

## Test Certificate

| | |
|---|---|
| **TEST METHOD** | ASTM C97M-18 |
| **TEST DATE** | 19-11-21 |
| **CLIENT** | Prolific Stone International Pty Ltd |
| **OUR REFERENCE** | PSI1121-1 |
| **SAMPLE** | Tiliqua Sawn Bluestone |
| **SURFACE FINISH** | Sawn |
| **SAMPLE ORIGIN** | Not specified : Not specified |
| **SAMPLING DATE** | 18-11-21 |
| **SHAPE and NOMINAL SIZE** | Prism: 50mm x 50mm x 50mm |

**Conditioning:** Dried min 48 hrs @ 60deg C / Soaked for 48 hours @ 22 deg C

| Test Number | Specimen Identification | Dried Mass (g) | Soaked mass (g) | Suspended mass (g) | Bulk SG (kg.m-3) | % Absorption by Volume | % Absorption by Weight |
|---|---|---|---|---|---|---|---|
| W11874 | B342/21 | 324.49 | 329.97 | 207.43 | 2,648 | 4.5 | 1.7 |
| W11875 | B342/22 | 319.31 | 325.15 | 203.32 | 2,621 | 4.8 | 1.8 |
| W11876 | B342/23 | 324.04 | 329.67 | 206.95 | 2,640 | 4.6 | 1.7 |
| W11877 | B342/24 | 317.04 | 323.58 | 200.79 | 2,582 | 5.3 | 2.1 |
| W11878 | B342/25 | 322.60 | 328.79 | 204.84 | 2,603 | 5.0 | 1.9 |

**MEAN BULK SPECIFIC GRAVITY** ($kg.m^{-3}$) **2,619 ± 2** ($u_{95}$)

*STANDARD DEVIATION* 27

**MEAN ABSORPTION BY Volume (%)** **4.8% ± 0.10** ($u_{95}$)

*STANDARD DEVIATION* 0.34%

**MEAN ABSORPTION BY Weight (%)** **1.8% ± 0.04** ($u_{95}$)

*STANDARD DEVIATION* 0.15%

**COMMENTS/VARIATIONS**

*NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.*

**TESTED BY:** Mark Milevski

**APPROVED SIGNATORY:**

**NAME:** James P Mann

**ISSUE DATE:** 25-Nov-21

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# FLEXURAL STRENGTH
## Test Certificate

**TEST METHOD** ASTM C880M-18
**TEST DATE** 19-11-21
**CLIENT** Prolific Stone International Pty Ltd
**OUR REFERENCE** PSI1121-1
**SAMPLE** Tiliqua Sawn Bluestone **SAMPLE TYPE** Basalt
**SAMPLE ORIGIN** Not specified : Not specified
**SAMPLING DATE** 18-11-21
**SHAPE and NOMINAL SIZE** Prism: 350mm x 100mm x 30mm
**LOAD ORIENTATION TO FINISH** Perp to Wearing Face **FINISH IN TENSION** Sawn
**TEST EQUIPMENT** Electronic Universal Force Testing Machine, AssettID: S1114

**Conditioning:** Dried for minimum 48 hours @ 60 deg C

| Test Number | Specimen Identification | Span (mm) | Test Condition | Load Orientation | Width | Thickness (mm) | Max. Load (Newtons) | Dried Strength (MPa) |
|---|---|---|---|---|---|---|---|---|
| F8549 | B342/11 | 300 | Dried | Perp to Wearing Face | 100.3 | 29.5 | 6193 | 15.9 |
| F8550 | B342/12 | 300 | Dried | Perp to Wearing Face | 100.2 | 29.6 | 6734 | 17.2 |
| F8551 | B342/13 | 300 | Dried | Perp to Wearing Face | 100.2 | 30.2 | 7939 | 19.6 |
| F8552 | B342/14 | 300 | Dried | Perp to Wearing Face | 100.3 | 29.7 | 6202 | 15.8 |
| F8553 | B342/15 | 300 | Dried | Perp to Wearing Face | 100.3 | 29.4 | 6124 | 15.9 |

MEAN DRIED FLEXURAL STRENGTH at 30mm thickness, with Sawn finish in tension. (MPa): **16.9** ± 0.3 ($u_{95}$)
Standard Deviation: **1.6**

**Conditioning:** Soaked for 48 hours @ 22 deg C

| Test Number | Specimen Identification | Span (mm) | Test Condition | Load Orientation | Width | Thickness (mm) | Max. Load (Newtons) | Soaked Strength (MPa) |
|---|---|---|---|---|---|---|---|---|
| F8554 | B342/16 | 300 | Soaked | Perp to Wearing Face | 100.3 | 28.7 | 6528 | 17.8 |
| F8555 | B342/17 | 300 | Soaked | Perp to Wearing Face | 100.3 | 29.9 | 6109 | 15.4 |
| F8556 | B342/18 | 300 | Soaked | Perp to Wearing Face | 100.2 | 29.4 | 9224 | 24.0 |
| F8557 | B342/19 | 300 | Soaked | Perp to Wearing Face | 100.3 | 28.6 | 5121 | 14.1 |
| F8558 | B342/20 | 300 | Soaked | Perp to Wearing Face | 100.4 | 30.0 | 6683 | 16.7 |

MEAN SOAKED FLEXURAL STRENGTH at 30mm thickness, with Sawn finish in tension. (MPa): **17.6** ± 0.4 ($u_{95}$)
Standard Deviation: **3.9**

**COMMENTS/VARIATIONS**

*NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.*

**TESTED BY:** Mark Milevski
**APPROVED SIGNATORY:**
**NAME:** James P Mann

**ISSUE DATE:** 24-Nov-21

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# COMPRESSIVE STRENGTH OF DIMENSION STONE

## Test Certificate

| | |
|---|---|
| TEST METHOD | ASTM C170M-17 |
| TEST DATE | 19-11-21 |
| CLIENT | Prolific Stone International Pty Ltd |
| OUR REFERENCE | PSI1121-1 |
| SAMPLE | Tiliqua Sawn Bluestone |
| SURFACE FINISH | Sawn |
| SAMPLE ORIGIN | Not specified : Not specified |
| SAMPLING DATE 18-11-21 | |
| SHAPE and NOMINAL SIZE | PRISM: 50x50x50 mm |
| DIRECTION OF LOAD TO RIFT | Unknown |
| TEST EQUIPMENT | Hydraulic Compression force testing Machine, AssettID: S1113 |

**Conditioning:** Dried for minimum 48 hours @ 60 deg C

| Test Number | Specimen Identification | Test Condition | Length (mm) | Width 1 (mm) | Width 2 (mm) | Max. Load (Newtons) | Compressive Strength(MPa) |
|---|---|---|---|---|---|---|---|
| C8066 | B342/1 | Dried | 49.3 | 49.9 | 50.1 | 370670 | 148 |
| C8067 | B342/2 | Dried | 49.2 | 50.0 | 50.1 | 381570 | 152 |
| C8068 | B342/3 | Dried | 50.0 | 50.0 | 49.5 | 430330 | 174 |
| C8069 | B342/4 | Dried | 50.0 | 50.1 | 49.7 | 412170 | 166 |
| C8070 | B342/5 | Dried | 50.2 | 50.1 | 49.1 | 421870 | 172 |

**MEAN DRIED COMPRESSIVE STRENGTH (MPa): 162 ± 2.0** ($u_{95}$)

**Standard Deviation: 11.6**

**Conditioning:** Soaked for 48 hours @ 22 deg C

| Test Number | Specimen Identification | Test Condition | Length (mm) | Width 1 (mm) | Width 2 (mm) | Max. Load (Newtons) | Compressive Strength(MPa) |
|---|---|---|---|---|---|---|---|
| C8071 | B342/6 | Soaked | 50.1 | 50.1 | 49.3 | 358850 | 145 |
| C8072 | B342/7 | Soaked | 50.1 | 49.8 | 50.2 | 395430 | 158 |
| C8073 | B342/8 | Soaked | 50.0 | 50.2 | 49.9 | 373790 | 149 |
| C8074 | B342/9 | Soaked | 50.3 | 50.3 | 49.2 | 319590 | 129 |
| C8075 | B342/10 | Soaked | 49.3 | 50.3 | 50.4 | 349680 | 138 |

**MEAN SOAKED COMPRESSIVE STRENGTH (MPa): 144 ± 1.7** ($u_{95}$)

**Standard Deviation: 11.1**

**COMMENTS/VARIATIONS**

*NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.*

**TESTED BY:** Mark Milevski

**APPROVED SIGNATORY:**

**NAME:** James P Mann

**ISSUE DATE:** 24-Nov-21

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# ABRASION RESISTANCE
## Test Certificate

| | |
|---|---|
| **TEST METHOD** | ASTM C1353-20 |
| **TEST DATE** | 19-11-21 |
| **CLIENT** | Prolific Stone International Pty Ltd |
| **OUR REFERENCE** | PSI1121-1 |
| **SAMPLE** | Tiliqua Sawn Bluestone |
| **SURFACE FINISH** | Sawn |
| **SAMPLE ORIGIN** | Not specified : Not specified |
| **SAMPLING DATE** 18-11-21 | |
| **SHAPE and NOMINAL SIZE** | Prism: 100mm x 100mm |

**Conditioning:** Dried @ 60 deg C for 48 hours
**Relative Humidity:** 53%
**Bulk SG:** **2.61**

| Test Number | Specimen Identification | Total Cycles | Initial Mass (g) | Final Mass (g) | Weight Loss (g) | Index of Abrasion Resistance |
|---|---|---|---|---|---|---|
| A8073 | B342/31 | 1000 | 230.46 | 228.37 | 2.09 | 46.7 |
| A8074 | B342/32 | 1000 | 201.09 | 198.34 | 2.75 | 34.1 |
| A8075 | B342/33 | 1000 | 210.51 | 208.10 | 2.41 | 40.2 |

**MEAN INDEX OF ABRASION RESISTANCE:** **40.3** **±0.7** ($u_{95}$)
**Standard Deviation:** **6.3**

**COMMENTS/VARIATIONS**

*NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.*

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**NAME:** James P Mann

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# WET SLIP RESISTANCE (AS 4586:2013 APP A)

## Test Certificate

| | | | |
|---|---|---|---|
| **TEST METHOD** | AS 4586:2013 Appendix A (Wet Pendulum) | | |
| **TEST DATE** | 19-11-21 | | |
| **CLIENT** | Prolific Stone International Pty Ltd | | |
| **OUR REFERENCE** | PSI1121-1 | | |
| **SAMPLE** | Tiliqua Sawn Bluestone | | |
| **SURFACE FINISH** | Sawn / Rubbed | | |
| **SAMPLE ORIGIN** | Not specified : Not specified | | |
| **SAMPLING DATE** | 18-11-21 | **TEST LOCATION:** | SI Laboratory |
| **SHAPE and NOMINAL SIZE** | Prism: 300mm x 300mm | | |
| **AIR TEMPERATURE** | 18.7 $^{o}$ C | **SITE:** | SI Laboratory |
| **WEATHER** | Not Applicable | | |
| **TEST TYPE** | Unfixed | | |
| **ANGLE OF TEST** | Horizontal | | |
| **SLIDER TYPE** | Slider 96 | **SLIDER EXPIRY** | 22-03-22 |
| **SLIDER PREPARATION** | Slider passed 3x over 400 grit paper, 10x over 3mic lapping film. | | |
| **SURFACE PREPARATION** | Washed with potable water and cloth | | |
| **SURFACE CONDITION** | As supplied | | |

| Test Number | Orientation | BPN Readings | Mean |
|---|---|---|---|
| S26292 | B342/26 Random | 67, 67, 67, 67, 67 | 67 |
| S26293 | B342/27 Random | 67, 67, 67, 66, 66 | 66 |
| S26294 | B342/28 Random | 70, 70, 70, 70, 70 | 70 |
| S26295 | B342/29 Random | 66, 66, 66, 66, 66 | 66 |
| S26296 | B342/30 Random | 68, 68, 68, 68, 68 | 68 |

**MEAN Wet SLIP RESISTANCE VALUE (SRV):** **67** ±2 ($u_{95}$)

**SLIP RESISTANCE CLASSIFICATION:** **P5**

**COMMENTS/VARIATIONS**

*NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.*

**TESTED BY:** Mark Milevski

**APPROVED SIGNATORY:**

**NAME:** James P Mann

**ISSUE DATE:** 19-Nov-21

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# Petrographic Analysis of Dimension Stone

| | |
|---|---|
| **Test Method** | SI-PET incorporating AS1141.26 |
| **Client** | Prolific Stone International Pty Ltd |
| **Test Date** | 30/11/21 |
| **Stone name / ID / Job ID** | Tiliqua Sawn Bluestone / B342 / PSI1121-1 |
| **Testing Officer** | Thomas Baggs |
| **Commercial classification[1]** | Bluestone / Basalt |
| **Geological classification** | Basalt |

| **Composition** | |
|---|---|
| **Component** | **Primary / Secondary / Void** |
| Plagioclase Feldspar | Primary |
| Pyroxenes | Primary |
| Olivine | Primary |
| Ilmenite | Primary |
| Iron Oxide Hydroxides | Secondary |
| Sericite | Secondary |
| Vesicles | Void |

| | |
|---|---|
| **Secondary Mineral Content** | 1.1% |
| **Void Content** | 12.1% |
| **Textural features** | • Fine-crystalline basalt<br>• Crystal size ranges from <1 µm (sericite/iron oxide hydroxides) to up to 300 µm (some pyroxene crystals)<br>• Most plagioclase feldspar crystals fall between 50 µm and 200 µm.<br>• Phaneritic crystals.<br>• Relatively homogenous distribution of crystals. Most plagioclase crystals are euhedral. Pyroxenes are interstitial and subhedral. |

[1] Classified in accordance with the definitions detailed in Standard ASTM C119-20.

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## Photographs & photomicrographs

**Plate 1:** Hand specimen photograph of slabs used for preparation of thin sections.

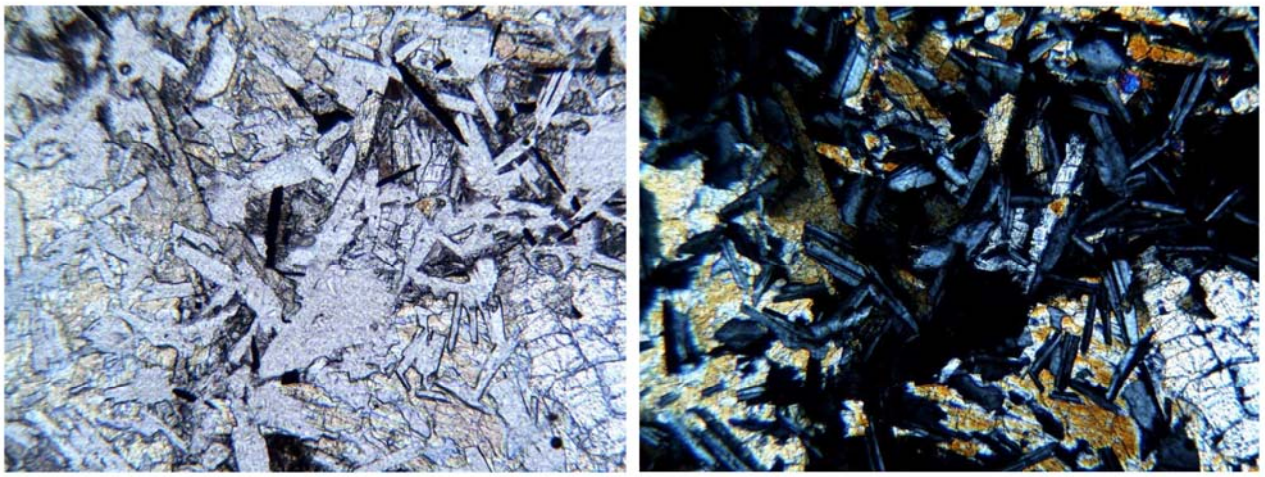

**Plate 2:** Magnification x100. Plane-polarised light (PPL) on left image, cross-polarised light (XPL) on right image. Typical appearance of thin section when viewed using a petrographic polarising light microscope. Tabular to elongate plagioclase feldspar crystals (colourless in PPL) form in overlapping lath pattern. Pyroxene crystals (yellow to light brown crystals) form interstitial to these feldspar crystals. Black-opaque, needle shaped ilmenite crystals are also randomly scattered throughout.

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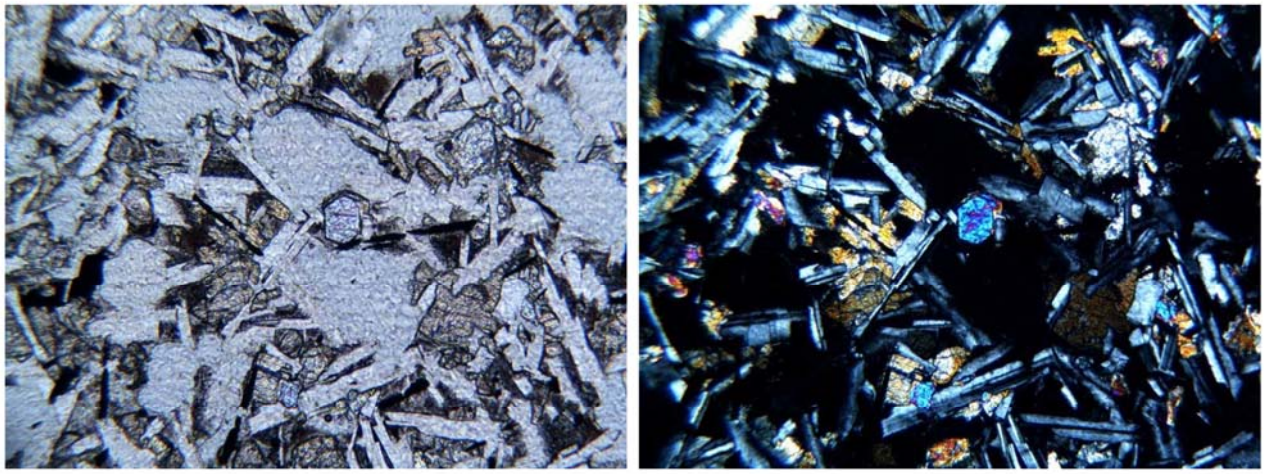

**Plate 3:** Magnification x100. Plane-polarised light (PPL) on left image, cross-polarised light (XPL) on right image. Another typical appearance of one of the thin section samples when viewed using a petrographic polarising light microscope.