test, where a disc of the test material is loaded across a diameter, is often employed. The technique involves loading disc-shaped specimens in compression across their diameter. Such loading generates a tensile stress at the center of the disc in a direction perpendicular to the direction of applied load (in the plane of the disc face). When the applied load reaches a critical level, the disc splits lengthwise in tension.

21 samples were tested for Brazilian Tensile Strength Test, 3 samples for each temperature i.e. 3 samples were heated in furnace for 7 days (40-hour alternate heating) and then tested in laboratory for tensile strength.

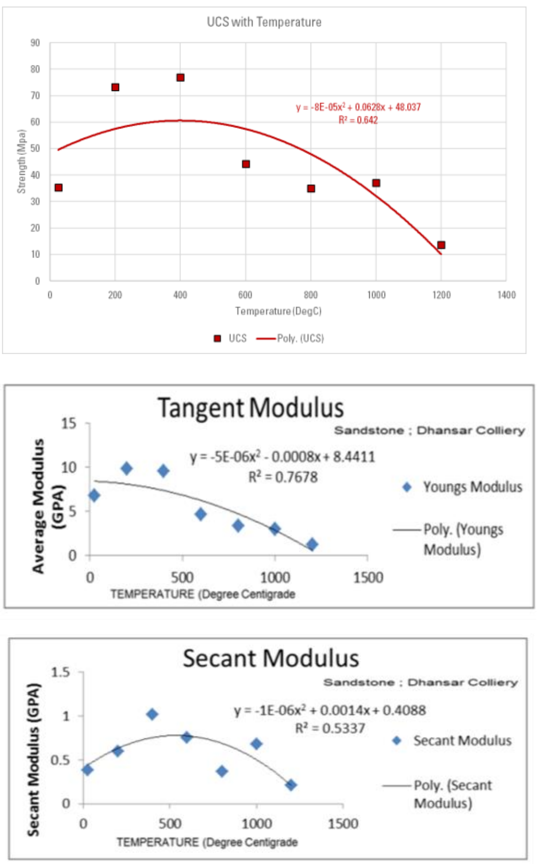

Figure 8: Variation of UCS, tangent modulus and secant modulus with Temperature

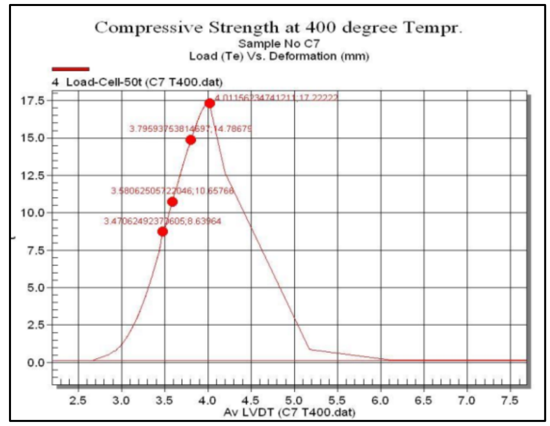

Figure 9: Stress strain profile obtained for a rock sample. UCS, tangent modulus and secant modulus are estimated from this curve.

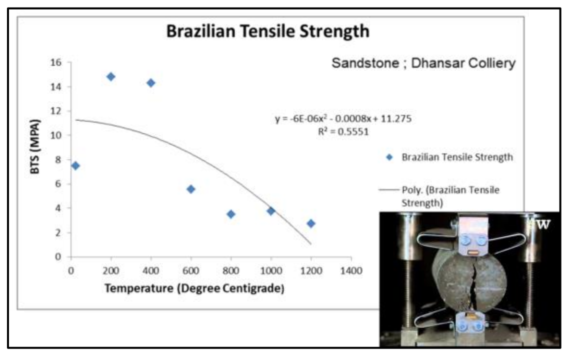

Figure 10: Variation of Brazilian tensile strength at various temperatures

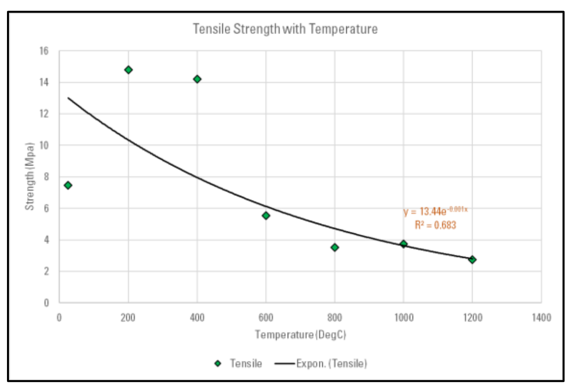

Figure 11: Load (te) versus time plot for determination of tensile strength by Brazilian test at 400deg centigrade for a rock sample

8. Mineralogy & Grain Size Study

Thin sections were prepared for sandstone rock samples heated to different temperatures to understand and analysis the changes at granular level. **Figure-12**

to 14 shows the microscopic view of thin sections prepared from rock samples. The summary of observations is listed in **Table-1**

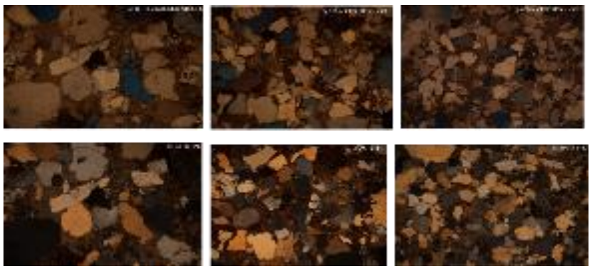

Figure 12: Observations on Thin Section Analysis at different temperatures at atmospheric, 200deg C and 400degC

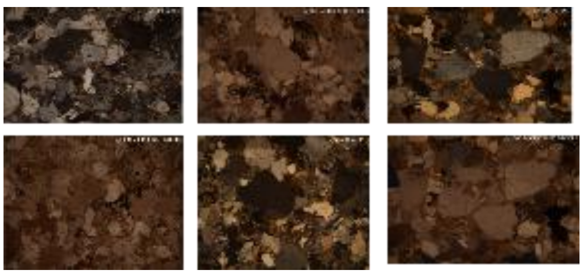

Figure 13: Observations on Thin Section Analysis at different temperatures at 600degC, 800degC and 1000degC

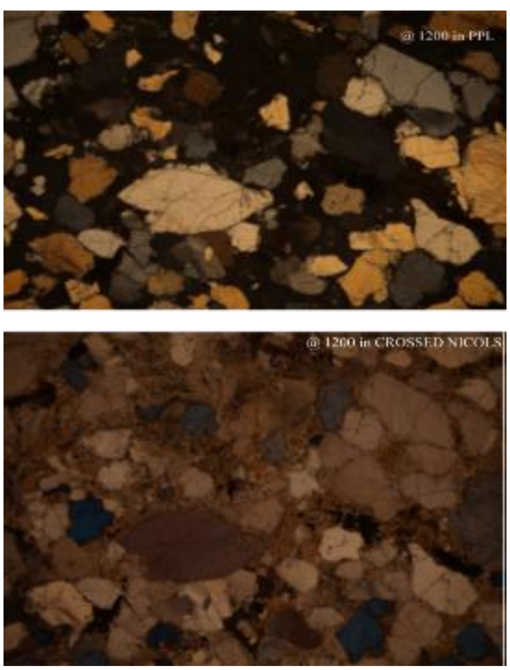

Figure 14: Observations on Thin Section Analysis at 1200degC temperatures

Table 1: Summary of observations observed on thin section analysis

Temp (DegC)	Observation
Room Temp (RT)	Mainly consist of Quartz grains, little feldspar(k), muscovite & other mica minerals. cementing material is fine silica.
200	Same as seen at room temperature.
400	Decrease in size of quartz grains, decrease in visibility of muscovite, quartz grains showed uneven fractures in them.
600	Same as in 400 with increase in visibility of feldspar, increase in fractures in quartz grains with little inclusion by surrounding cement.
800	Quartz grains decreases in number with more uneven fractures. A little appearance of garnet type mineral.
1000	Quartz grain in good number than previous, more mica minerals visible as binding material, highly fractured (uneven) quartz grains, quartz is of brittle nature.
1200	Quartz grains have no close contact with each other i.e. dispersed surrounded by cement, binding material increased, mica is less, quartz showed cherty appearance, high number of uneven fractures, some places brittle nature. 120-degree dihedral angle of quartz visible.

Conclusions

Based on the comprehensive experiments conducted sandstone rock samples at different temperatures following key take away points are summarized below:

- Protodyakonov's strength test showed a continuous decrease in strength on exposure to high temperatures.
- NCB Cone Indenter test showed almost no correlation amongst values with respect to change in temperature.
- Shore Scleroscope hardness showed a gradual decrease in hardness on exposure to high temperatures.
- Schmidt Hammer rebound test showed gradual decrease in strength.
- Sonic Logger showed continuous decrease in P-Wave velocity till 800 DegC and then a slight increase at upto 1200 DegC
- Water holding capacity increased continuously upto 800 DegC and a gradual decrease upto 1200 DegC
- Destructive tests showed that uniaxial compressive strength increase continuously upto 500 DegC & then

decreased continuously at high temperatures, at 1200 DegC the strength decreased to 38% of that at room temperature.

- Tensile strength also showed similar trend as compressive strength, firstly increased upto 400 DegC & then decreased upto 1200 DegC, at 1200 DegC the tensile strength decreased to 36% of that at room temperature.
- Mineralogical studies from thin sections showed decrease in size and amount of quartz grains with increase in temperature
- There was large increase in uneven fractures in quartz grains with increase in temperature, muscovite was clearly visible in mid-range temperatures like 400DegC & gradually disappeared at high temperatures.
- It is confirmed that temperature has great impact on rock strength, increase in strength upto 500DegC and then decrease upto 1200DegC can be attributed to change in compactness, porosity of rock and due to chemical & structural change in quartz & feldspar grains. The rock gets porous with increase in void spaces i.e. compactness decreases upto 800DegC and then a gradual increase upto 1200DegC
- The decrease in size and amount of quartz grains with increase in temperature followed by large increase in uneven fractures in quartz grains affected the rock strength.

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