Effect of intrinsic coal properties on self-heating rates

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Presentation Outline

- Spontaneous combustion assessment strategy
- Coal samples, equipment and testing
- Self-heating curves for different coal ranks
- Self-heating relationships
- R_{70} vs RIT
- Conclusions and future work

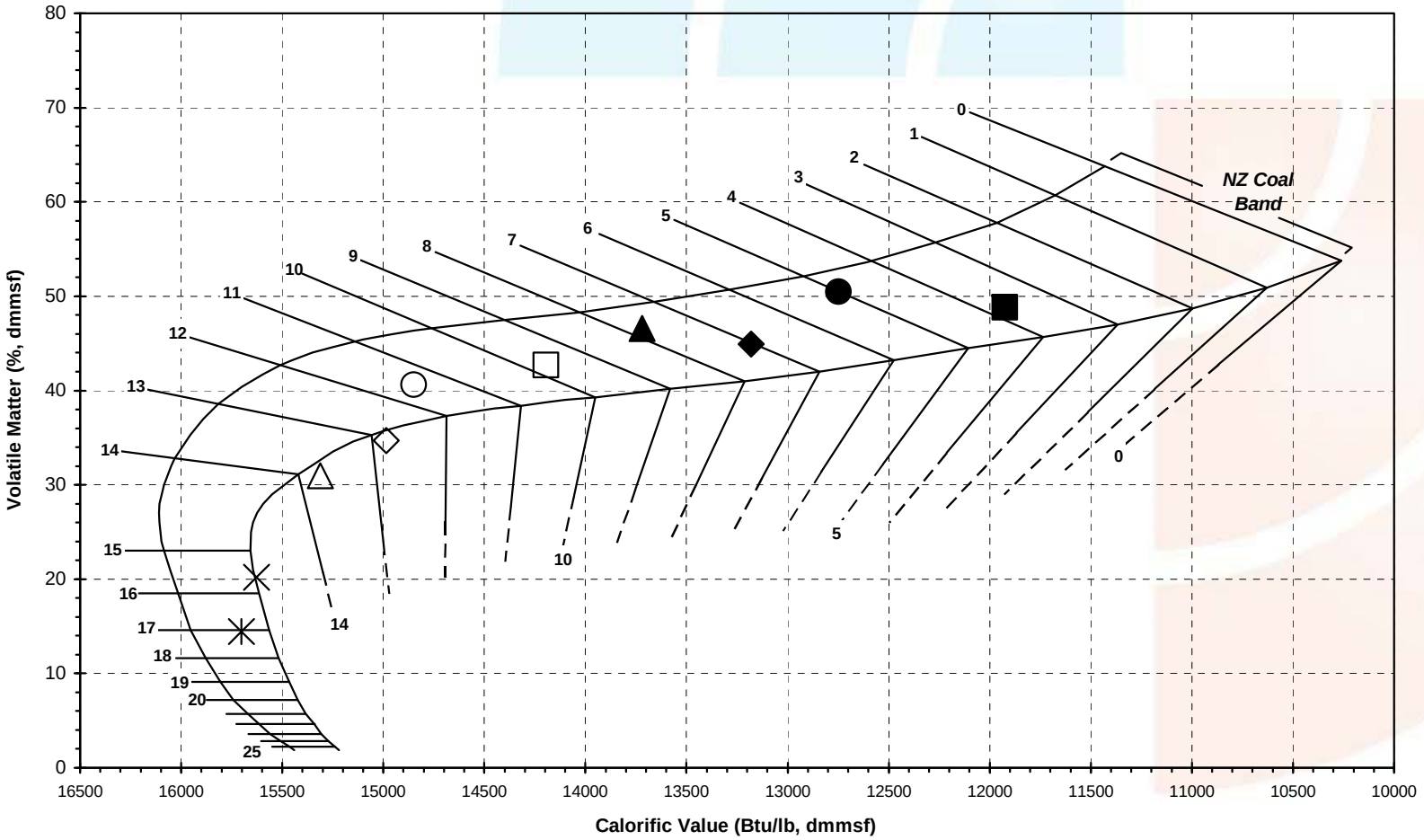
Strategy for assessing sponcom propensity

- Four stages of assessment
  - Stage I – Coal quality indexing
  - Stage II – Small-scale coal behaviour/nature testing (UQ adiabatic oven)
  - Stage III – Bulk-scale coal response testing (UQ 2-metre column)
  - Stage IV – Coal environment modelling

Indexing parameters

- Assessment of coal spontaneous combustion propensity has been limited to a variety of small-scale self-heating index tests
- R_{70}, CPT, SHT_{min}, IRH, TTR, RIT
- Type of sample
  - core, face or stockpile
- Age of sample
  - storage method (under water, under nitrogen, frozen)

Suggate rank plot of coals studied



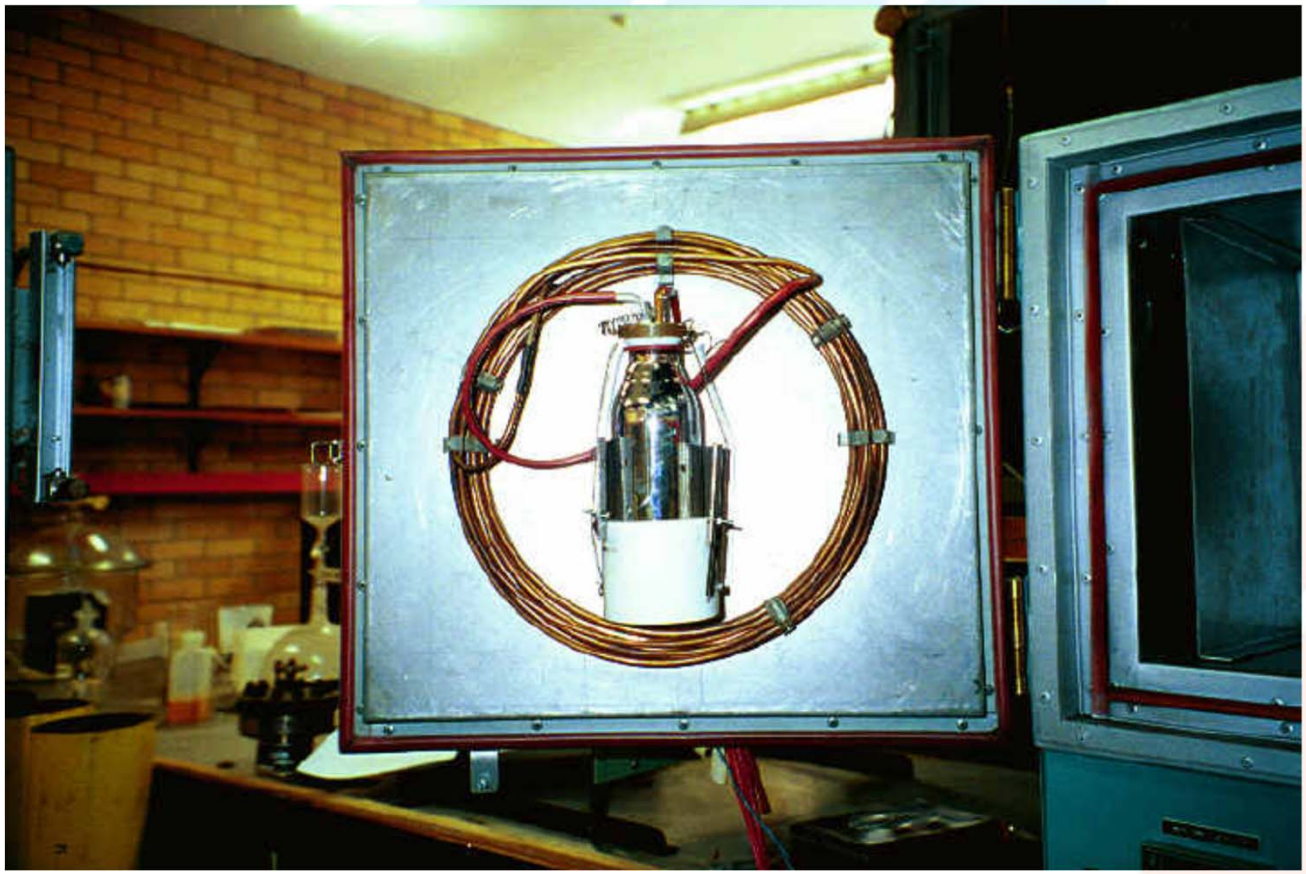
R_{70} Test procedure

- 150 g coal crushed to <212 micron
- Dried under nitrogen at 110°C for at least 16h, then cooled to 40°C
- Transferred to thermos and stabilised under nitrogen in adiabatic oven at 40°C ± 0.2°C
- Flow switched to oxygen at 50 mL/min
- Temperature change recorded by computer
- R_{70} values determined as the average self-heating rate from 40°C to 70°C, expressed in °C/h

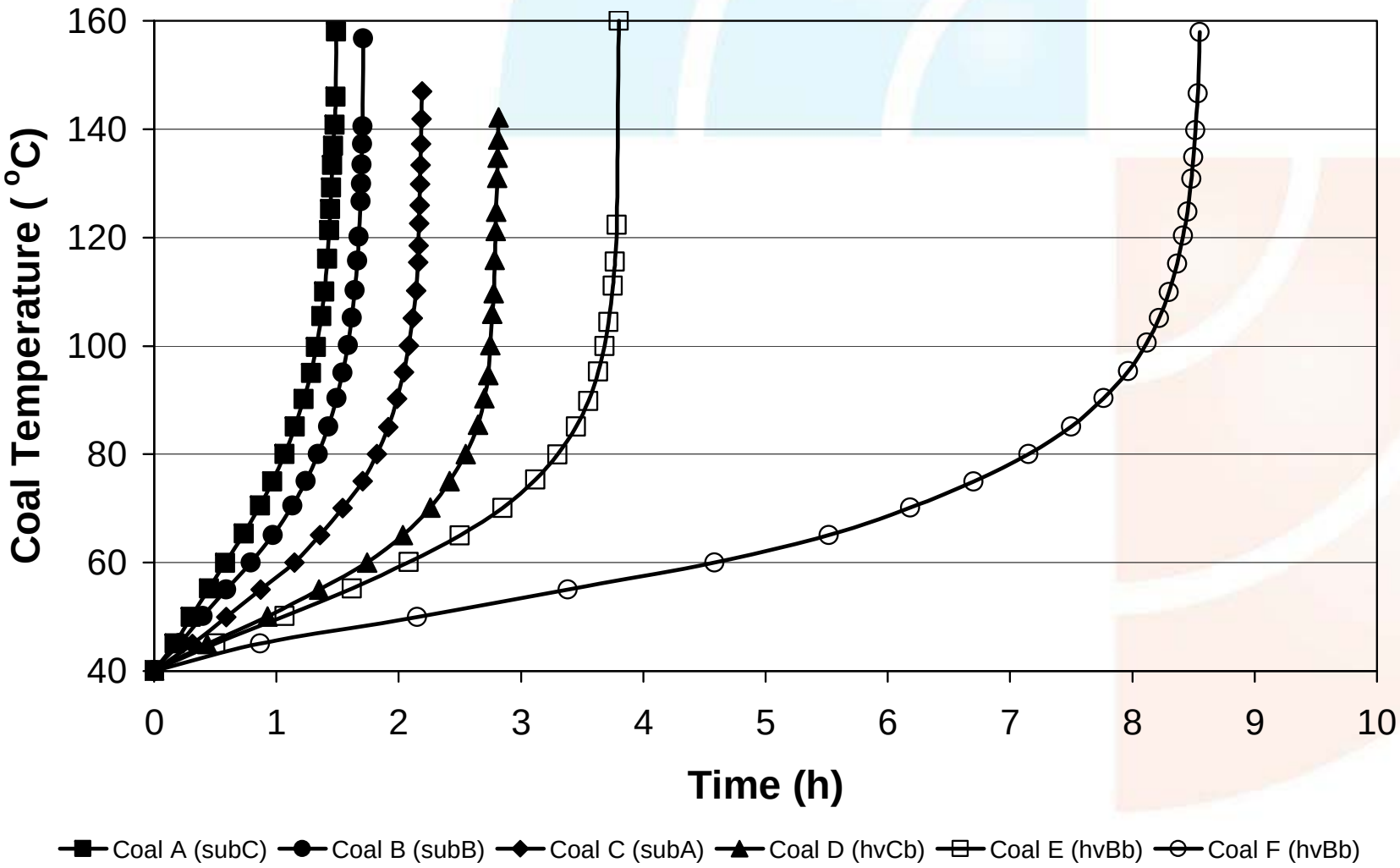
Adiabatic oven exterior

Adiabatic oven interior

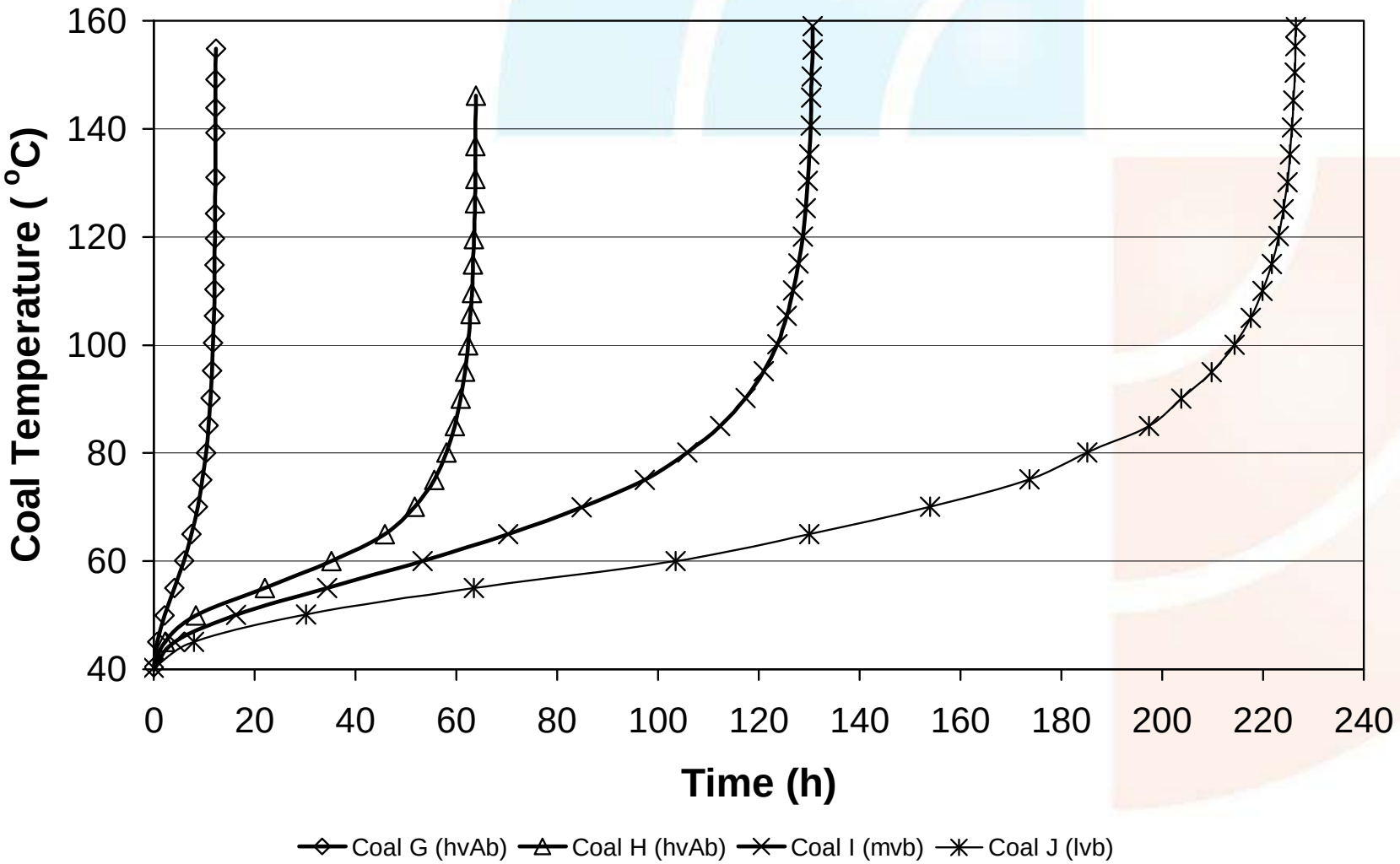
Reaction vessel housing



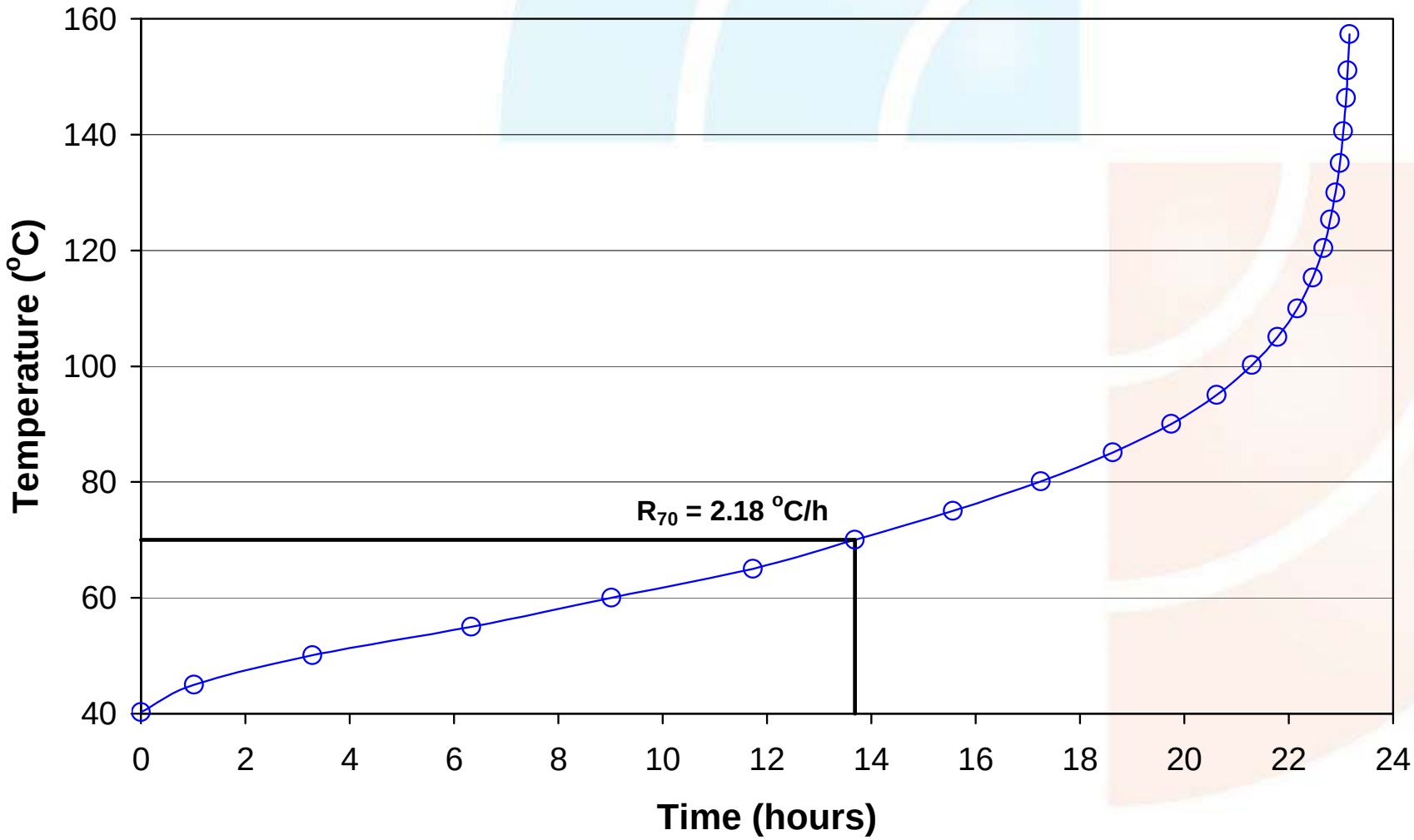
Adiabatic coal self-heating curves for low to medium rank coals



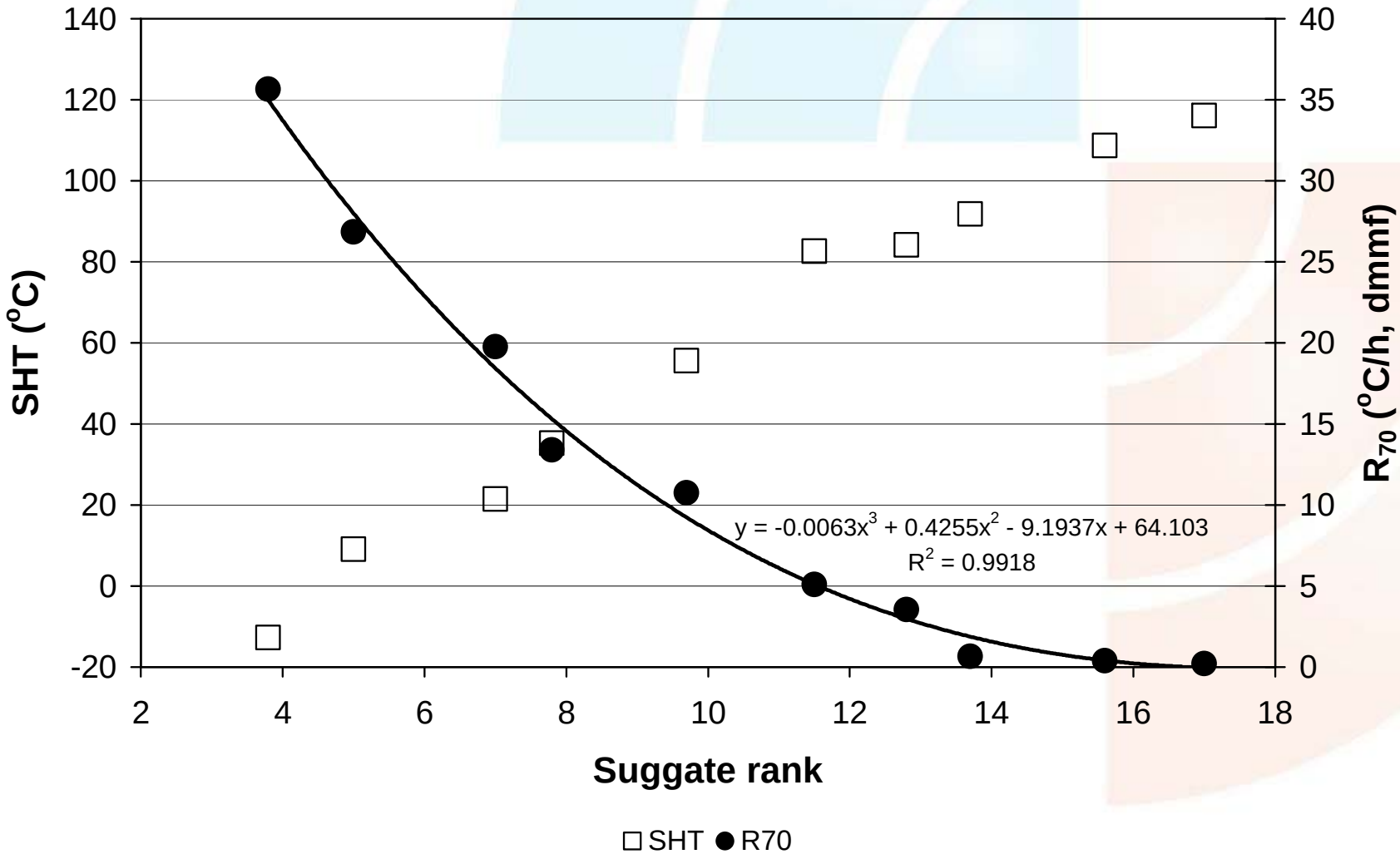
Adiabatic coal self-heating curves for high rank coals



R_{70} value determination



SHT values using original Smith and Lazzara equation



Previous rating of R_{70} values

- <0.5 °C/h low propensity
- 0.5-0.8 °C/h medium propensity
- >0.8 °C/h high propensity
- ratings set over 25 years ago based on Queensland coals
- currently mining a far greater range of coals, particularly from the lower end of the high volatile bituminous rank

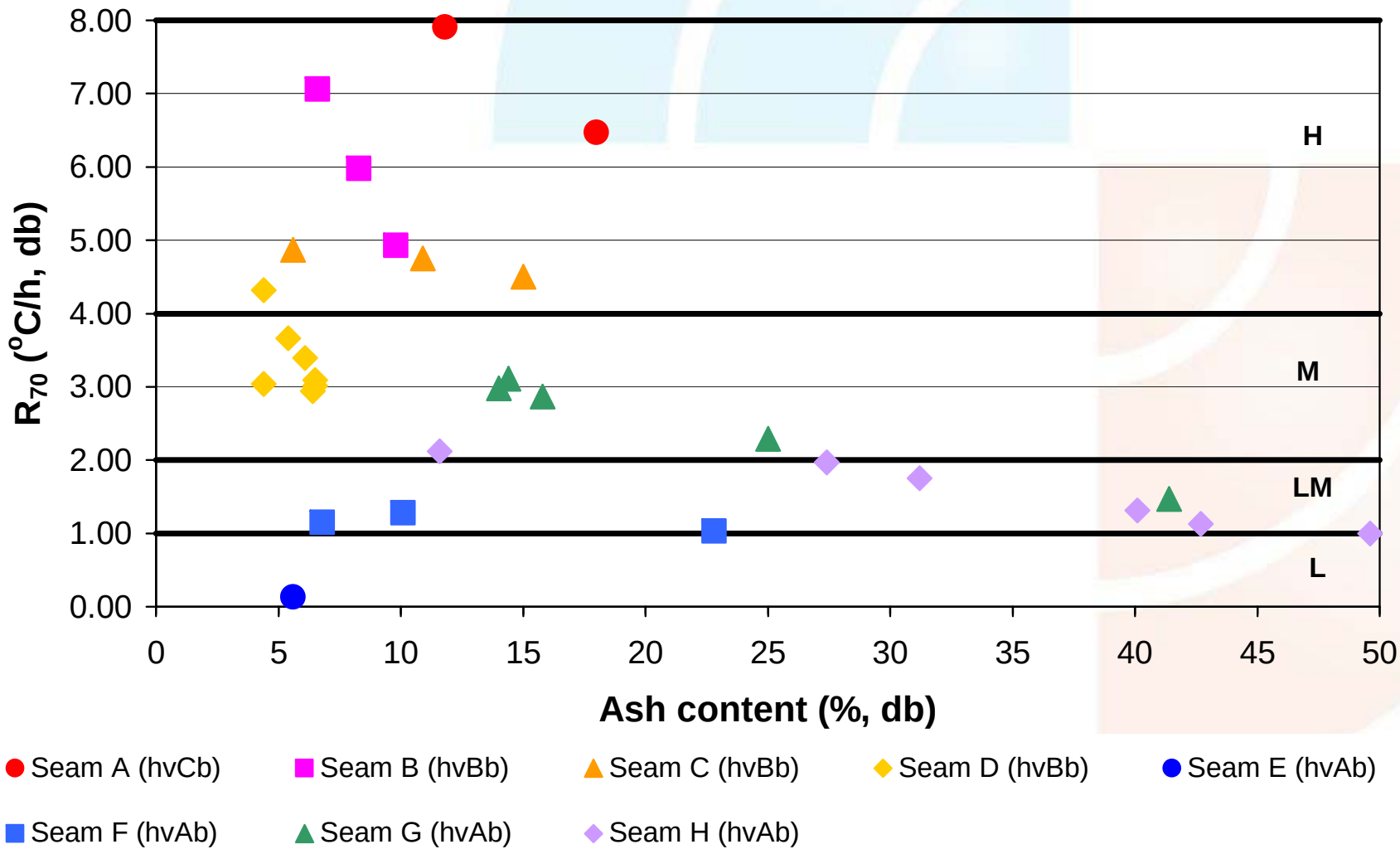
Current rating of R_{70} values for NSW coals

- $R_{70} < 1.0$ °C/h low (Class I)
- $1.0 \leq R_{70} < 2$ °C/h low - medium (Class II)
- $2 \leq R_{70} < 4$ °C/h medium (Class III)
- $4 \leq R_{70} < 8$ °C/h high (Class IV)
- $8 \leq R_{70} < 16$ °C/h very high (Class V)
- $16 \leq R_{70} < 32$ °C/h ultra high (Class VI)
- ≥ 32 °C/h extremely high (Class VII)

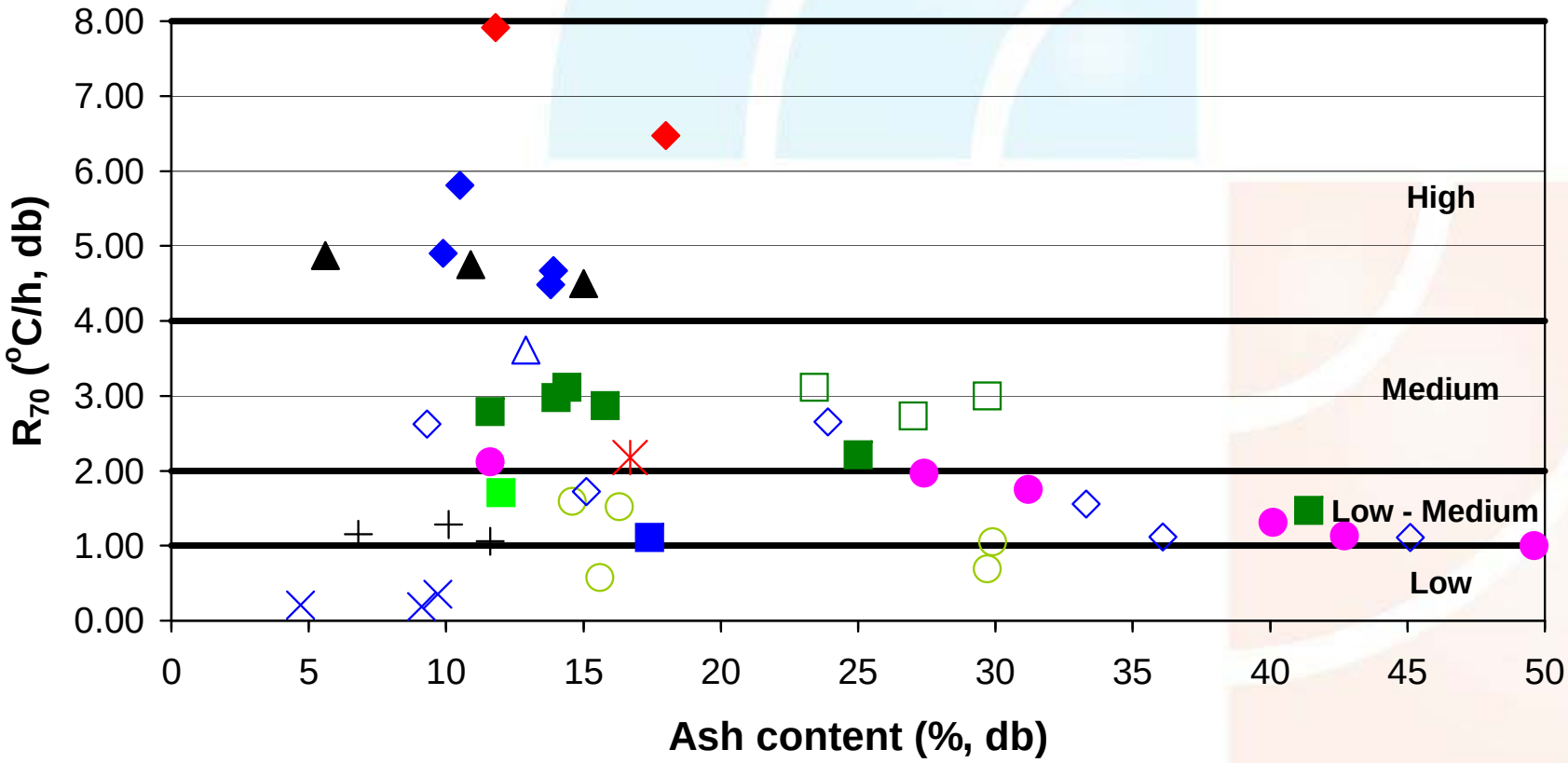
Current rating of R_{70} values for QLD coals

- $R_{70} < 0.5$ °C/h low (Class I)
- $0.5 \leq R_{70} < 1$ °C/h low - medium (Class II)
- $1 \leq R_{70} < 2$ °C/h medium (Class III)
- $2 \leq R_{70} < 4$ °C/h high (Class IV)
- $4 \leq R_{70} < 8$ °C/h very high (Class V)
- $8 \leq R_{70} < 16$ °C/h ultra high (Class VI)
- ≥ 16 °C/h extremely high (Class VII)

Relationship between R_{70} and ash content for hvb coals

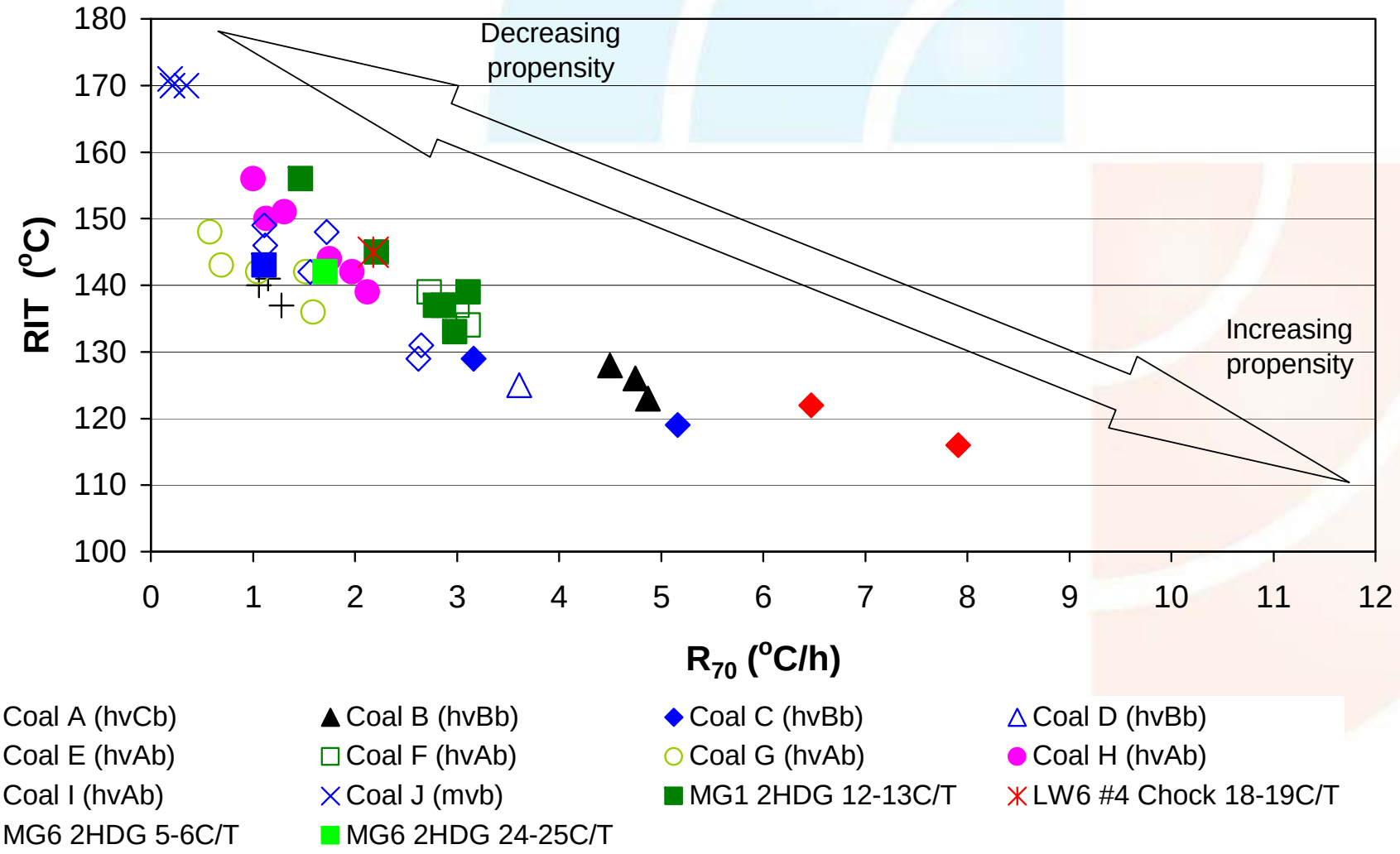


Recent mine-site review for a NSW longwall operation

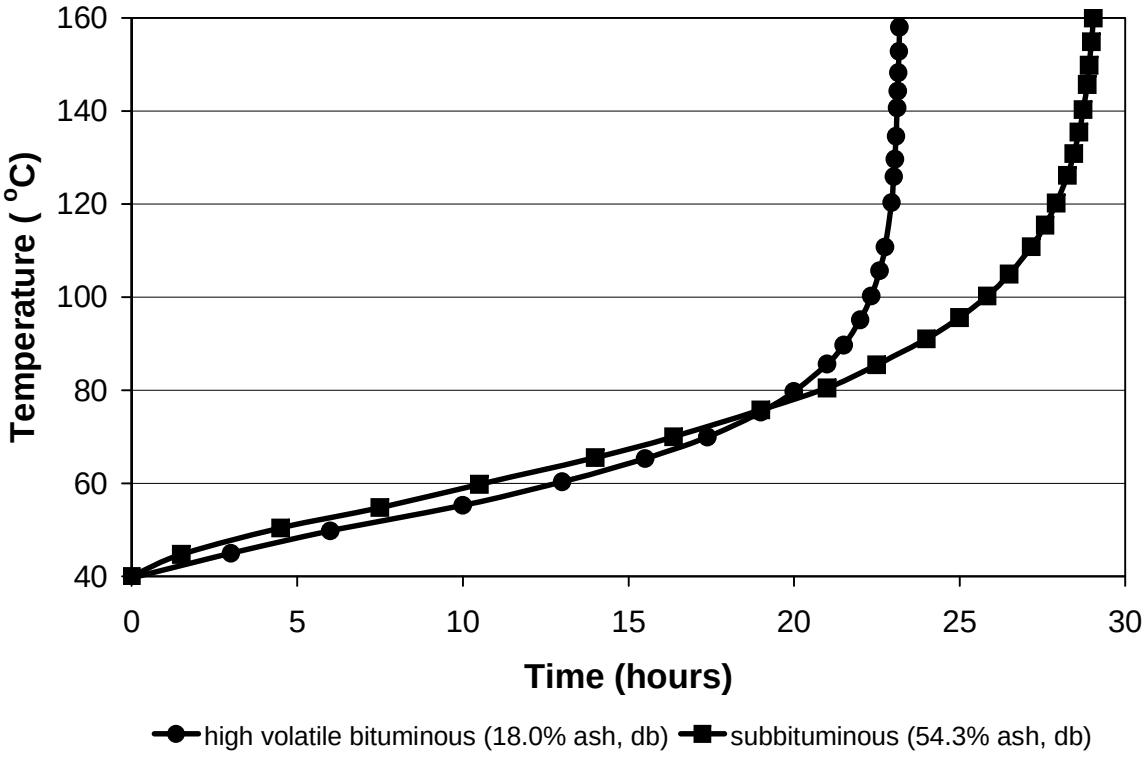


Coal A (hvCb)
Coal B (hvBb)
Coal C (hvBb)
Coal D (hvBb)
Coal E (hvAb)
Coal F (hvAb)
Coal G (hvAb)
Coal H (hvAb)
Coal I (hvAb)
Coal J (mvb)
MG1 2HDG 12-13C/T
LW6 #4 Chock 18-19C/T
MG6 2HDG 5-6C/T
MG6 1-2HDG 24C/T

Relationship between R_{70} and RIT for Sydney Basin coals



Two coals with the same R_{70} self-heating rate



Conclusions and future work

- Defining site specific relationships for coal self-heating rates helps to identify and explain possible propensity variations between mines and within the same mine
- Using a combined low temperature and high temperature index system (R_{70} vs RIT) can provide a more accurate assessment of spontaneous combustion propensity that enables mining analogues to be clearly identified
- The UQ database now covers a wide range of Australian, New Zealand, Indonesian and US coals
- New mining areas from the Surat, Galilee and Gunnedah Basins in Australia will be added to the UQ database over the next six months