

# 4.1) 冲击变形能监测模型



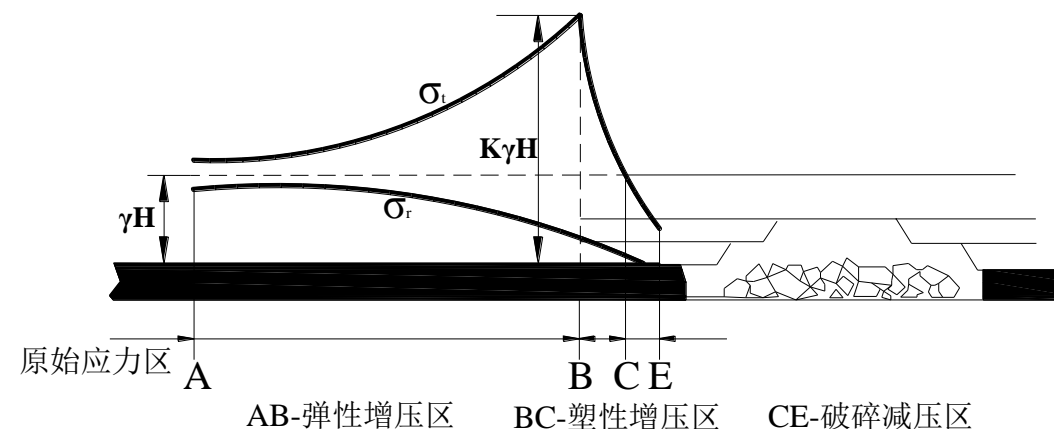
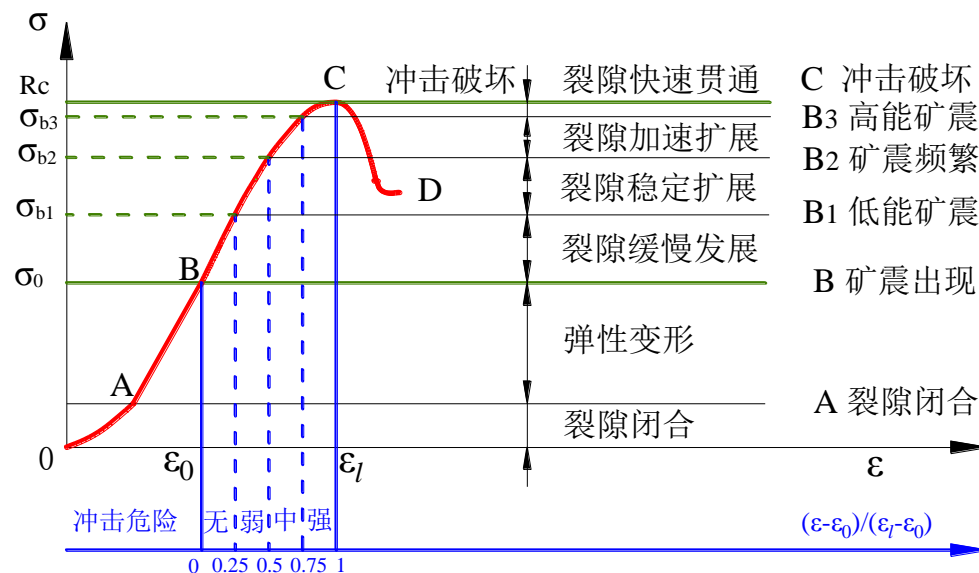
State Key Laboratory  
of Coal Resources and Safe Mining



## 冲击变性能监测预警指数指数 (2013)

$$\varepsilon_t = \sum_{i=1}^N \sqrt{E_i}$$

$$W_\varepsilon = \frac{\varepsilon_t - \varepsilon_0}{\varepsilon_l - \varepsilon_0}$$



$E_i$  -第*i*次矿震能量

$N$  -上次宏观破裂后的  
矿震次数

$\varepsilon_t$  -在*t*时刻的应变

$\varepsilon_l$  -宏观破裂时应变

$\varepsilon_0$  -初始应变

冲击危险指标	异常对应的危险性特征	$W_\varepsilon$
A	无	<0.25
B	弱	0.25-0.5
C	中等	0.5-0.75
D	强	>0.75

## 4.2) 冲击变形能时空监测



State Key Laboratory  
of Coal Resources and Safe M

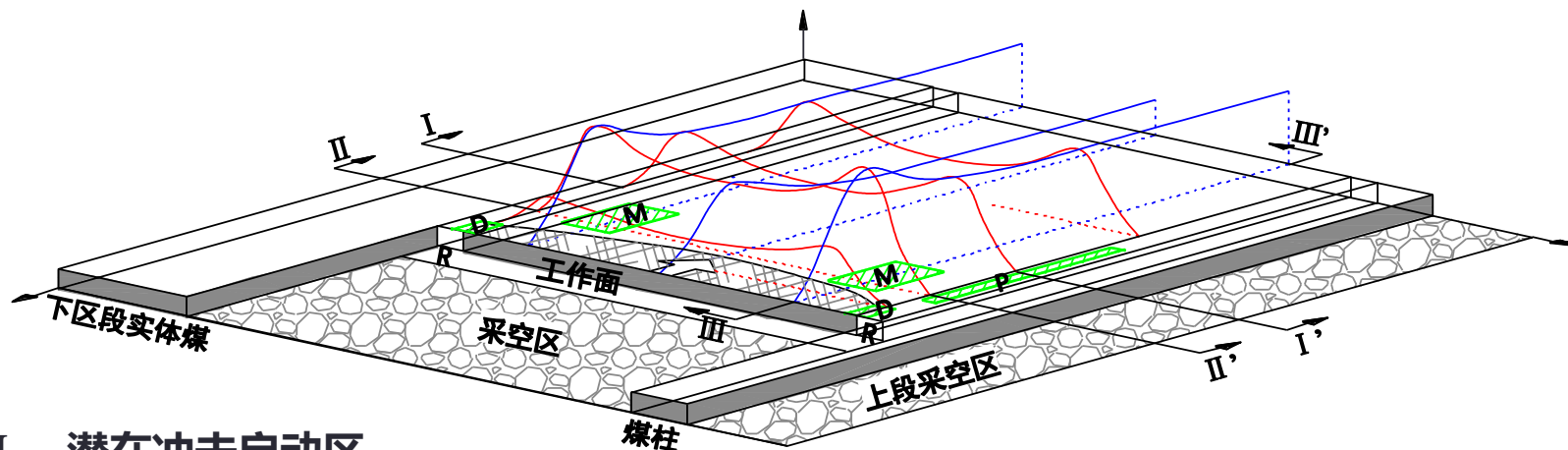


### 冲击变形能监测预警——时序与空间

$$W_{\varepsilon\text{-temporal}} = \frac{(\varepsilon - \varepsilon_{Nt-1}) + (\varepsilon_{Nt-1} - \varepsilon_{Nt-2}) + \cdots + (\varepsilon_1 - \varepsilon_0)}{(\varepsilon_l - \varepsilon_{Nl-1}) + (\varepsilon_{Nl-1} - \varepsilon_{Nl-2}) + \cdots + (\varepsilon_1 - \varepsilon_0)} = \frac{\varepsilon - \varepsilon_0}{\varepsilon_l - \varepsilon_0} = \frac{\sum_{i=1}^{Nt} \sqrt{U_{AE-i}}}{\sum_{i=1}^{Nl} \sqrt{U_{AE-i}}}$$

$$W_{\varepsilon\text{-spatial}} = \frac{e - e^{1-\beta(t)}}{e - 1}$$

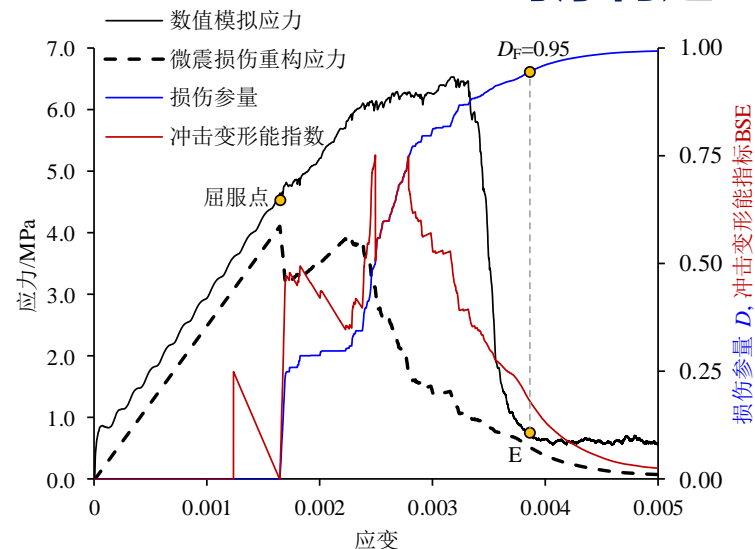
$$\beta(t) = (U_{\varepsilon} - U_{\varepsilon\text{-min}}) / (U_{\varepsilon\text{-max}} - U_{\varepsilon\text{-min}})$$



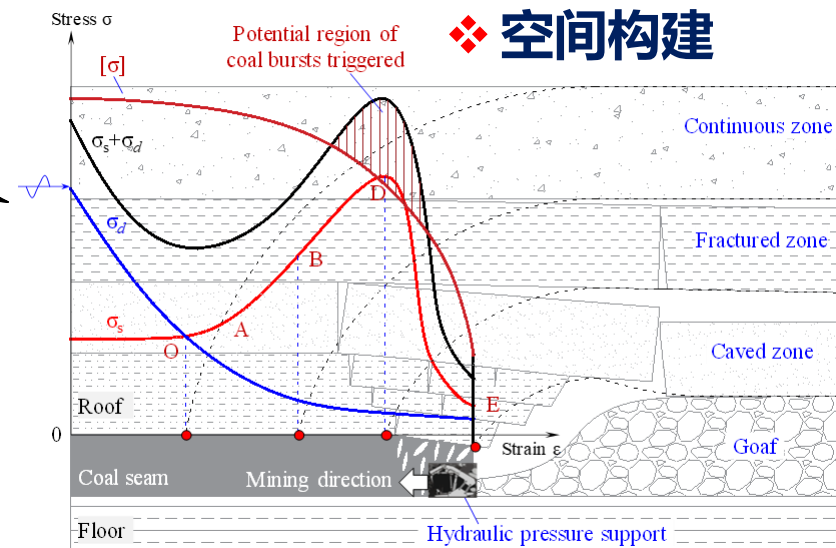
M — 潜在冲击启动区

P — 潜在冲击危险区

### 时序构建



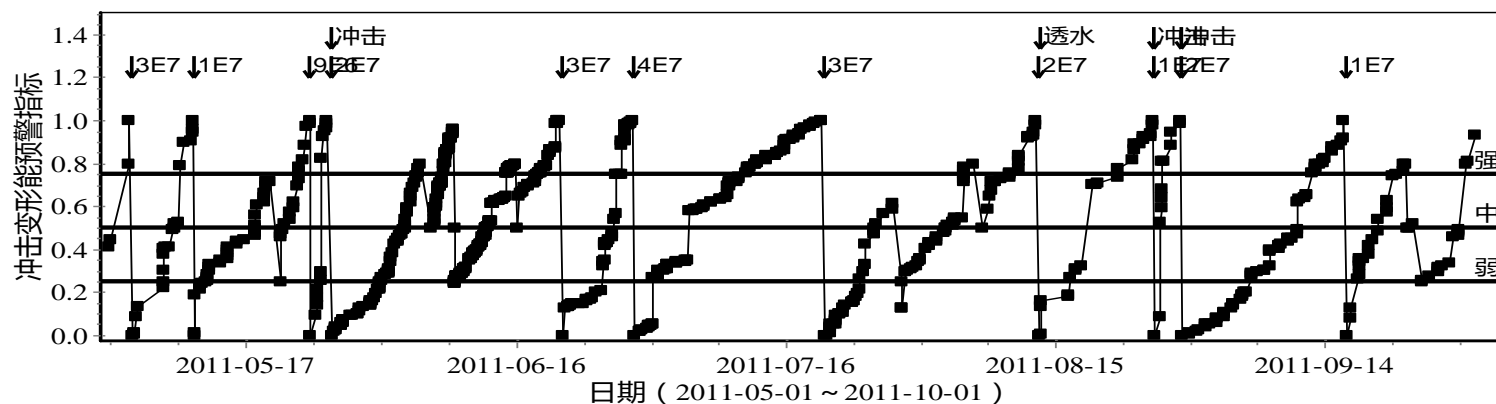
### 空间构建



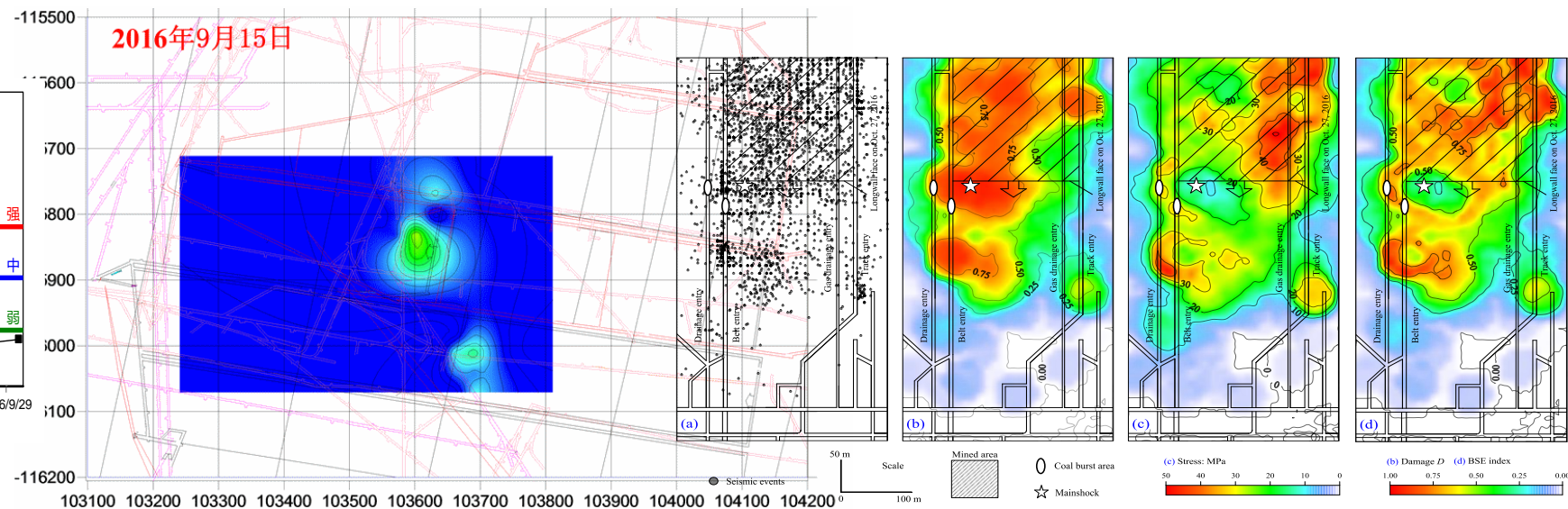
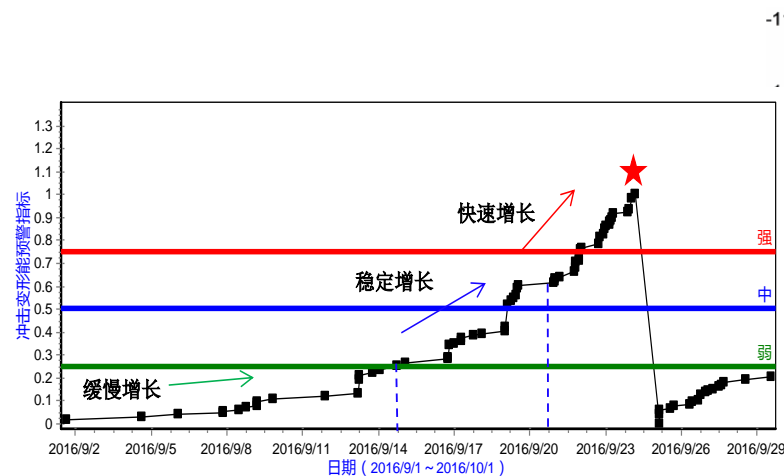
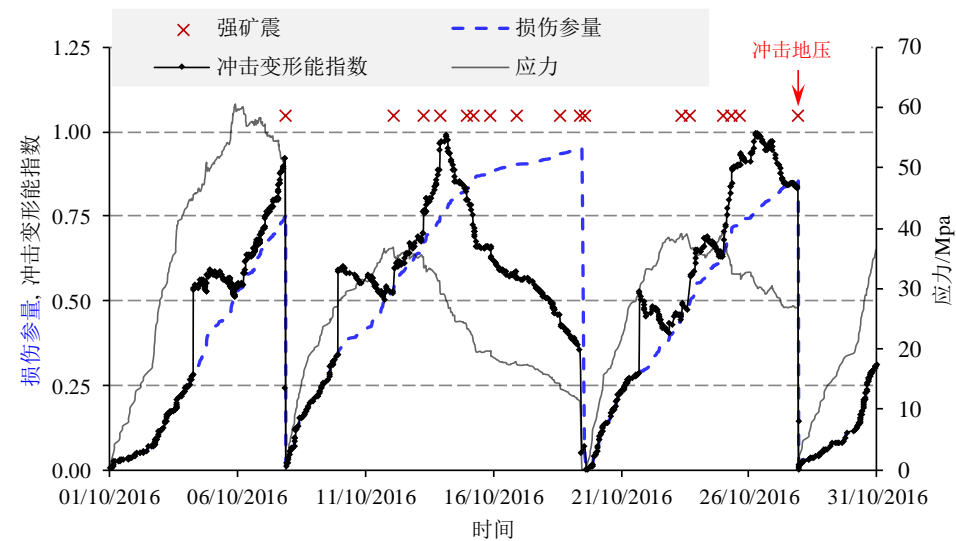
## 4.3) 冲击变形能监测预警技术



State Key Laboratory  
of Coal Resources and Safe M



冲击变形能预警（跃进，11次强矿震预警9次，预警率82%）



中国矿业大学优秀博士论文（2015）