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Multi-scale fracture damage associated with underground chemical explosions

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1 *Multi-Scale Fracture Damage Associated with Underground Chemical Explosions*

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8 **Keywords:** fractures; explosion-induced damage; underground explosions; granite

9 **Abstract**

10 Understanding rock damage induced by explosions is critical for a number of applications  
11 including the monitoring and verification of underground nuclear explosions, mine safety  
12 issues, and modeling fluid flow through fractured rock. We use core observations, televiewer  
13 logs, and thin section observations to investigate fracture damage associated with two  
14 successive underground chemical explosions (SPE2 and SPE3) in granitic rock at both the  
15 mesoscale and microscale. We compare the frequency and orientations of core-scale fractures,  
16 and the frequency of microfractures, between a pre-experiment core and three post-  
17 experiment cores. Natural fault zones and explosion-induced fractures in the vicinity of the  
18 explosive source are readily apparent in recovered core and in thin sections. Damage from  
19 faults and explosions is not always apparent in fracture frequency plots from televiewer logs,  
20 although orientation data from these logs suggests explosion-induced fracturing may not align  
21 with the pre-existing fracture sets. Core-scale observations indicate the extent of explosion-  
22 induced damage is 10.0 m after SPE2 and 6.8 m after SPE3, despite both a similar size and  
23 location for both explosions. At the microscale, damage is observed to a range distance of  $10.2$   
24  $\pm 0.9$  m after SPE2, and  $16.6 \pm 0.9$  and  $11.2 \pm 0.6$  in two different cores collected after SPE3.  
25 Additional explosion-induced damage, interpreted to be the result of spalling, is readily  
26 apparent near the surface, but only in the microfracture data. This depth extent and intensity of  
27 damage in the near-surface region also increased after an additional explosion. This study  
28 highlights the importance of evaluating structural damage at multiple scales for a more  
29 complete characterization of the damage, and particularly shows the importance of microscale  
30 observations for identifying spallation-induced damage.

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