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The rupture zone of an m2.2 earthquake within the mechanically heterogeneous Pretorius fault-zone, Tautona mine, South Africa (NELSAM project)

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We determined the mechanical properties of the fault-rocks and host rocks of the Pretorius fault-zone (TauTona mine, South Africa), and discuss the relations of these properties to the rupture zone of an m2.2 earthquake within this fault. The Pretorius fault is a 10 km long ENE trending, Archean fault with right-lateral displacement up to 200 m and vertical throw of 30-60 m. The fault-zone is 25-30 m wide with tens of anatomizing, non-parallel segments, and the fault-rock in these segments is a massive, well-cemented (sintered) cataclasite, known in South Africa as "pseudotachylyte". Sections of the Pretorius fault have been reactivated due to the mining activity. The rupture zone of one of these events, the m2.2 earthquake of December 12, 2004, was mapped in tunnels at depth of 3.6 km. The rupture zone was traced for 25 m horizontally and 8 m vertically and it revealed that 3 to 4 quasi-planar, crosscutting segments were reactivated within the Pretorius fault. Slip up to 25 mm occurred predominantly along the contacts between the quartzitic host rock and the Archean cataclasite. We determined the mechanical properties of 10 cataclasite samples and 24 quartzite samples under confining pressures up to 200 MPa; the samples were collected from boreholes drilled across the Pretorius fault. The two rock types are distinctly different. The cataclasite is significantly weaker than the quartzite in uniaxial strength (97 MPa versus 204 MPa), cohesion (49 MPa versus 28 MPa), and coefficient of internal friction (0.58 versus 0.81). On the other hand, the cataclasite is more brittle than the quartzite: the first displays negligible inelastic deformation and its yield point is 0.85 of ultimate strength, whereas the second displays significant weakening and inelastic deformation starts at 0.25 the ultimate strength. Further, the failed cataclasite samples display negligible, pervasive damage off the main fault, the quartzite shows pervasive off-fault

damage. The Young's modulus and Poisson's ratio of the two rocks are close: 69 GPa and 0.17 for the cataclasite and 79 GPa and 0.19 for the quartzite. We propose that the Pretorius fault formed initially as a 25-30 m wide zone of damaged quartzitic rocks. Segments of localized shear developed later within the damaged quartzite, and the gouge of these segments was finally sintered into cataclasite. The recent m2.2 rupture is localized along the cataclasite-quartzite due to strength contrast between the two rock types. This suggests that slip weakening is the dominant weakening mechanism of this event. The research was supported by NSF Continental Dynamics grant 0409605 and ICDP.