National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Decoding Dynamics of Magmatic Systems and Interactions with External Stress Perturbations
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Venue	: ER-303
Date and Time	: 18 Jul 2025 (11:30 am)
Abstract	: Volcanoes and hydrothermal systems offer key insights into subsurface magmatic processes and pose serious hazards through eruptions, seismicity, and ground deformation. Increasing human settlement near these zones, due to environmental and economic benefits, elevates the need for robust hazard management through advanced monitoring, public awareness, and evacuation planning. These systems often produce lithospheric deformation influenced by complex interactions between internal magmatic activity and external forces. During volcanic unrest, inflation-related signals&mdashsuch as ground tilt, gas emissions, and seismicity&mdashcan reveal magma chamber dynamics. This inflation is further complicated by hydrothermal fluids, whose circulation may evolve due to stress changes, leading to enhanced deformation. As the magma chamber nears a critical stress state, it becomes more sensitive to periodic external forces, especially tidal loading, which strongly modulates microseismicity in the pre-eruption stage. Caldera fault systems also contribute to this triggering behavior, reflecting a dynamic interplay of internal and external stresses. While eruptions are episodic, climate-driven factors&mdashlike sea level, glaciation, and rainfall&mdashcan influence their timing in some systems. Periodic loading, such as tides or seasonal hydrological changes, may induce stress sufficient to trigger eruptions. Hydrothermal seismicity, especially in submarine and mid-oceanic ridge settings, is similarly affected by tidal forces. Tides influence fluid flow by altering fracture permeability near the brittle-ductile transition zone, with shallow crusts experiencing stronger modulation. At greater depths, while direct tidal stresses are lower, they can still affect fluid flow and seismicity through pressure changes. This study highlights how interactions between external (tidal, hydrological) and internal (magma chamber dynamics) processes vary across eruption cycles. Short-period external forces are especially influential during the critically stressed pre-eruption phase. Moreover, fluid reservoirs at varying depths respond differently to tidal cycles, emphasizing the spatial-temporal complexity of these systems. A better grasp of these interactions is essential for improving volcanic and hydrothermal hazard forecasting and mitigation.