OBITUARY

Earth and Planetary Physics
7: 603–605, 2023
doi: 10.26464/epp2023077

An YIN (1959–2023)

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Professor An Yin, a world-class geologist, was well known for his significant contribution to the understanding of tectonic evolution of the Earth, especially the Himalayas and Tibetan plateau (Yin A and Harrison, 2000; Yin A, 2006), and other planets and their satellites, such as Enceladus and Europa (Yin A et al., 2016; Leonard et al., 2018). He applied mechanical analysis to structural geology in order to understand the deformation process, not only on terrestrial planets (Yin A, 2012), but also on icy Charon, the largest moon of Pluto (Chen HZ and Yin A, 2022). He passed away unexpectedly in the afternoon of July 12, 2023 while teaching a summer field camp at White Mountain, California, USA.

An Yin was born in Harbin, China, in 1959. He grew up in an intellectual family, with his parents being medical school professors. He passed the national university entry examination in 1978 and enrolled in Peking University as an undergraduate in the Geology Department. He continued as a graduate student at Peking University focusing on Precambrian geology of North China under the guidance of the late Professor Qian Xianglin. His desire to learn more about how the Earth has evolved led him to the USA in 1983, where he earned a Ph.D. degree in Geology at the University of Southern California (USC) under the supervision of Professor Gregory A. Davis. In 1987, right before his Ph.D. defense, he was offered a tenure track acting Assistant Professor position at the University of California, Los Angeles (UCLA). After officially receiving his doctoral degree from USC in 1988, An Yin was appointed as an Assistant Professor. He was promoted to Associate Professor in 1993 and became a Full Professor at UCLA in 1996. He became Distinguished Professor at UCLA in 2022.

In recognition of his trail-blazing efforts in combining numerical modeling with field-based geology, An was awarded the Young Scientist Award (Donath Medal) and fellow of the Geological Society of America (GSA) in 1994. He was elected as a fellow of the American Geophysical Union in 2013. In 2022, An received the Penrose Medal, the highest medal at the GSA, for applying his tectonic and geophysical observations to help understand how the planetary lithosphere forms and deforms.

An served as Chief Editor for *Earth and Planetary Science Letters* (2014–2020) and *Tectonophysics* (2011–2014). Moreover, he contributed his expertise as an Associate Editor of the *Geological Society of American Bulletin* (2007–2019), the journal *Geology* (1996–1999, 2019–2021), and the *Journal of Asian Earth Sciences* (2002–2008). He was also a valued member of the Editorial Board of *Earth and Planetary Physics*.

Prof. An Yin on the field trip about the tectonic evolution of North American Cordillera in 2017.

An's research focused on studying how and why the lithospheres of Earth and other solar-system bodies deform, using mechanical analysis. His curiosity, courage, and creativity led him into many previously unexplored fields in Earth and planetary science. Over the decades, An continuously broadened his horizons — from the tectonic evolution of the North American Cordillera, the Himalayan region, the Tibetan Plateau, Central Asia, and Africa, to slow-slip earthquakes, to early Earth, and to other planets and icy satellites in the solar system. His work was characterized by brilliant ideas, daring hypotheses, and rigorous analyses.

His work on Earth usually started with intensive field investigations to create detailed geological maps of the study area, which typically culminated in construction of kinematic and mechanical models for the evolution of the lithosphere. His early-career, starting from the North American Cordilleran thrust systems and metamorphic core complexes, led him to develop models based on detailed field mapping and rigorous analytical solutions, and to explain the formation of low-angle normal faults (Yin A, 1989) and their three-dimensional structural variations (Yin A, 1991). He systematically advanced the critical-taper Coulomb wedge theory by offering elastic solutions for compressional and extensional wedges (Yin A, 1993, 1994).

In the meantime, An kept a continuous focus on the geology of

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Received 02 AUG 2023; Accepted 10 AUG 2023.
First Published online 01 SEP 2023.

China and East Asia. He and colleagues offered the first palinspastic reconstruction of the major blocks and terranes in China and adjacent regions, in a comprehensive review (Yin A and Nie S, 1996). This was followed by three even more influential review articles that focused on the Himalayan–Tibetan orogen (Yin A and Harrison, 2000), the Cenozoic Himalayan orogen (Yin A, 2006), and all of Asia (Yin A, 2010). These were accompanied and corroborated by, numerous studies that he, his students and colleagues conducted in key places such as the Qinling–Dabie, Gangdese, Himalaya, Karakoram, central and northern Tibetan plateau, Altyn Tagh, Pamir, Tarim, Tian Shan, and northeastern India. These studies have remarkably shaped our views on many critical issues, among which are the north–south trending rift system of southern Tibet (Yin A, 2000), the southern extent of the Karakoram fault (Murphy et al., 2002), the blueschist-bearing Qiangtang metamorphic belt (Kapp et al., 2003), the structural relationship between the Main Central Thrust and the South Tibetan Detachment System in the High Himalayas (Webb et al., 2007), the conjugate strike-slip fault system in central Tibet (Yin A and Taylor, 2011), and a possible seismic gap in North China (Yin A et al., 2015). At the same time, An Yin even managed to develop a new model for on-going deep (15–50 km) slow-slip events (Yin A et al., 2018a) and tectonic tremor (Yin A, 2018b) and to establish the plate convergence processes at ca. 2.0 Ga (Yin A et al., 2020).

An Yin's curiosity drove him to even deeper space. For the studies of other planets and satellites, An conducted comparisons between similar geological settings from the Earth and satellite images of these bodies and applied mechanical theory to understand their tectonic process (Yin A et al., 2016). He proposed a hypothesis of a primitive form of plate tectonics, which is expressed as left-slip transtensional deformation absorbed by east–west extension along the Valles Marineris, the longest and deepest system of canyons in the solar system (Yin A, 2012). These deformation features are similar to the fault systems in the Himalayas and Tibet, as well as those in the San Andreas Fault, as horizontal motion occurs along plate boundaries. His original plate tectonics model suggests that the outer shell of Mars is separated into two plates with very slow relative motion, compared with the Earth's, because its smaller size and lower thermal energy limit its tectonics. He and his student also investigated faulting and glaciation on Charon, Pluto's largest satellite (Chen HZ and Yin A, 2022).

An was an excellent advisor. He stimulated the curiosity of many students on the nature and evolution of Earth and other planets. He supervised more than 40 graduate students; many of them have since become world-class geologists. Dr. Paul A. Kapp, who was the 2008 recipient of the Donath Medal and a fellow of the GSA, is now a professor of Geology at the University of Arizona. Drs. Michael A. Murphy, Eric S. Cowgill, and Michael H. Taylor are professors at different universities in the USA and have been nominated as fellows of the GSA. Dr. Jessica Watkins, a recent Ph. D. student of An Yin, was selected as a NASA astronaut in 2017.

In addition to mentoring his students and postdocs at UCLA, An Yin devoted a significant portion of his energy and enthusiasm to advancing scientific research and education in China. He was one of the founding members of the International Professionals for Advancement of Chinese Earth Sciences (IPACES), a non-profit organization initially established in 1999 with the mission of promoting earth sciences research and education in China and international collaborations. He had collaborators and friends in many geoscience institutes in China, where he offered lectures and courses to numerous students and scholars. He had been leading two influential annual field trips on "Tectonic evolution of the North American Cordillera" (since 2015) and "Comparative studies of Phanerozoic intracontinental tectonics and volcanism between East Asia and Western North America" (since 2017) for Chinese scholars and students. The front cover of his field guidebooks prints a Chinese-English bi-lingual aphorism "Traveling ten-thousand miles is like reading ten-thousand books". He emphasized the importance of detailed field observations and understanding of field phenomena for Earth scientists. These field trips, attended by scholars from different disciplines, showcased classic geological phenomena, their tectonic history, and the mechanical theories behind them. These trips inspired many young minds through a combination of detailed field geological mapping and joint analysis of multi-discipline observations from geophysics, geology, and geochemistry.

An was a man of integrity. He held himself and his students and collaborators to strong moral principles. His students have shown their comprehensive capabilities not only in their geological science research, but also by emulating An's excellent personality in collaboration and social service, which deeply affected all who knew him. His integrity and dignity have remarkably shaped the way his students conduct scientific research. He set a high bar for the science community. An remains an inspiration to all who had the privilege of knowing him.

An frequently used the quotation "all models are wrong, but some are useful" when discussing geological models with colleagues and students. He encouraged them to look out for the valuable aspect of each study. Whether in the field, in the classroom, or in his office, he was always humorous. He had an amazing ability of captivating the curiosity of colleagues and students for scientific questions or cheering them up with his intentional accent, characteristic of northeastern China.

An's life was full, every single day from his college days to his expeditions in the Himalayas and Tibet, and to his recent endeavor for planetary science. His insatiable curiosity, unwavering courage, boundless creativity, relentless perseverance, infectious humor, and enduring passion for science, education, and daily life have been and will forever remain a source of inspiration for his family, friends, colleagues, and the entire scientific community.

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