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Bleaching and thermal stability of ESR signals in terrestrial carbonates

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1. Introduction

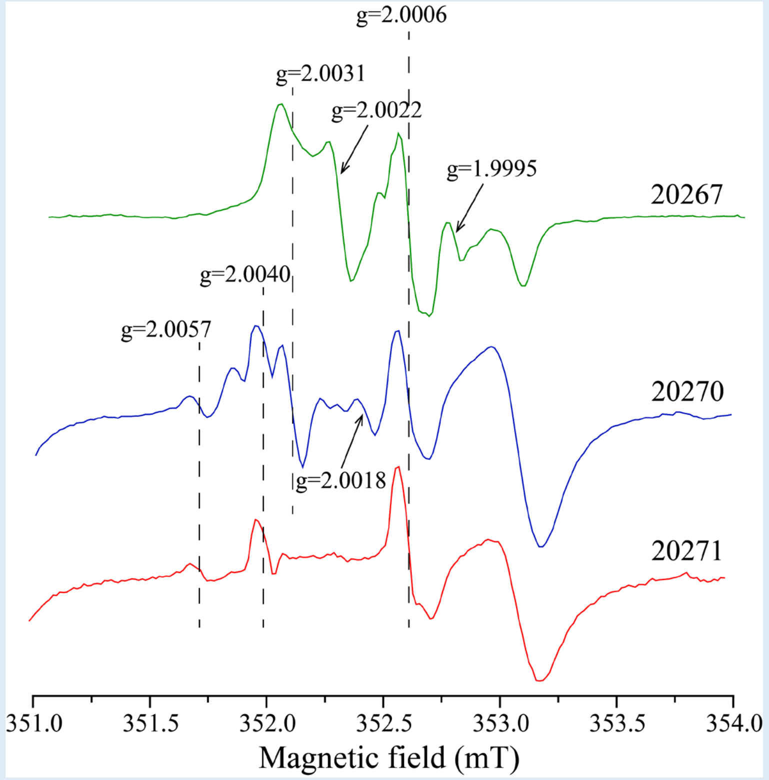

Fig.1 ESR spectra of terrestrial carbonates: recrystallized (20267), bedrock (20270), and calcite vein (20271), after gamma ray irradiation (1000Gy).

Direct dating of brittle fault activity is of great significance for establishing regional tectonic frameworks and studying seismic faults that pose geohazards(eg. Nuriel et al., 2015; Mottram et al., 2020). Calcite veins in fault zones and recrystallized carbonates produced on fault surfaces by fault activity proved to be two very efficient ESR dating materials (e.g. Tsakalo et al., 2018; Yin et al., 2021). However, little is known about the bleaching behavior and thermal stability of ESR signals in such terrestrial carbonates. We then collected three terrestrial carbonates (recrystallized, calcite vein, and carbonate bedrock) to investigate the properties of their ESR signals (Fig. 1).

2. Methods

the samples were gently crushed in an agate mortar, the sieve fraction of 100-200 µm was selected and each sample was divided into 160 mg aliquots. The Bleaching experiments were carried out using a SOL2 (Dr Hönle) solar light simulator from 1 h to 1600 h. The annealing experiments consist of isochron annealings of 15 min from 50℃ to 260℃ (Fig. 3). ESR measurements were performed at room temperature using an EMX Bruker X-band spectrometer. Instrumental settings were: microwave frequency 10 GHz; microwave power 0.2 mW; modulation frequency 100 kHz; modulation amplitude 0.1 mT. Taking into account the angular dependence, each aliquot was measured with three times after a rotation of 120° angle in the cavity, and studied from a mean value of the ESR intensities.

3. Results and discussion

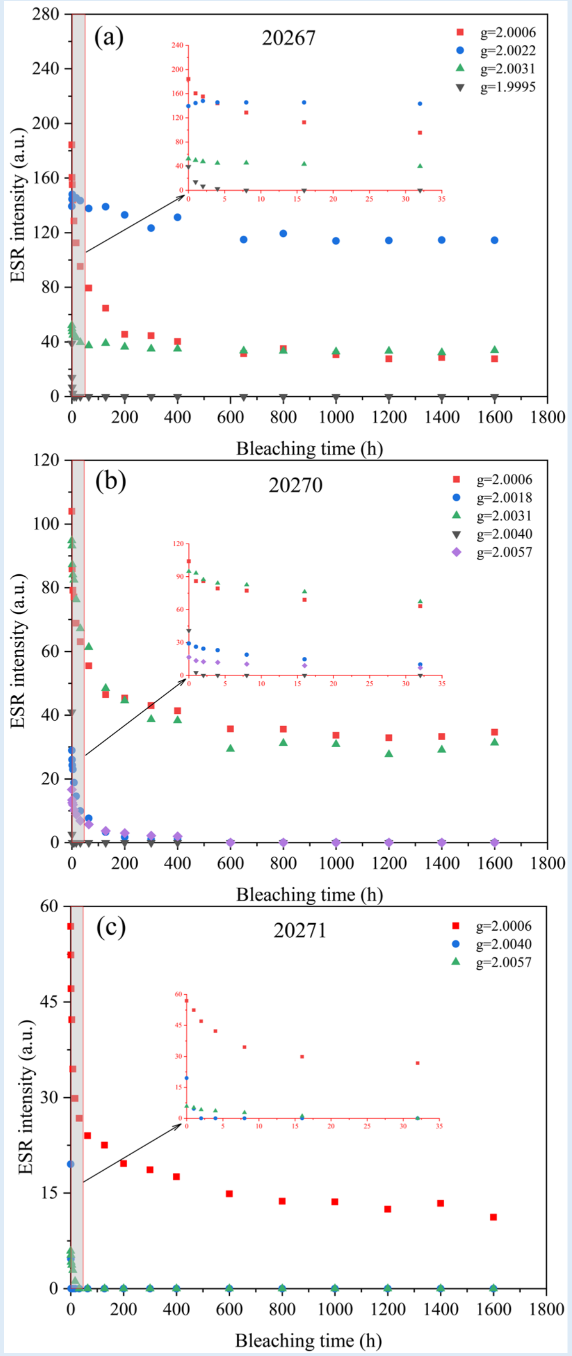

Fig. 2 the signal intensity changes with increasing bleaching time.

For recrystallized carbonate, The g=1.9995 can be completely bleached in only 10 h, while the other signals are bleached to a stable residual values in about 600 hours. Based on thermal stability, signals can be classified as: g=2.0006 ≈ g=2.0022 > g=2.0031 > g=1.9995.

For carbonate bedrock, the g=2.0040 can be fully bleached in only 2 h, which is the most sensitive to the sunlight. The g=2.0057 can also be bleached to zero by light exposure, and the exposure time is at least 600 hours. It is noteworthy that the intensities of this signal slightly increase with temperature.

For calcite vein, g=2.0040 can be fully bleached in 2 h, consistent with observations in bedrock sample. The complete disappearance of the g=2.0057 takes place at 32 h, indicating that this signal in calcite veins is more sensitive to sunlight than that in bedrock.

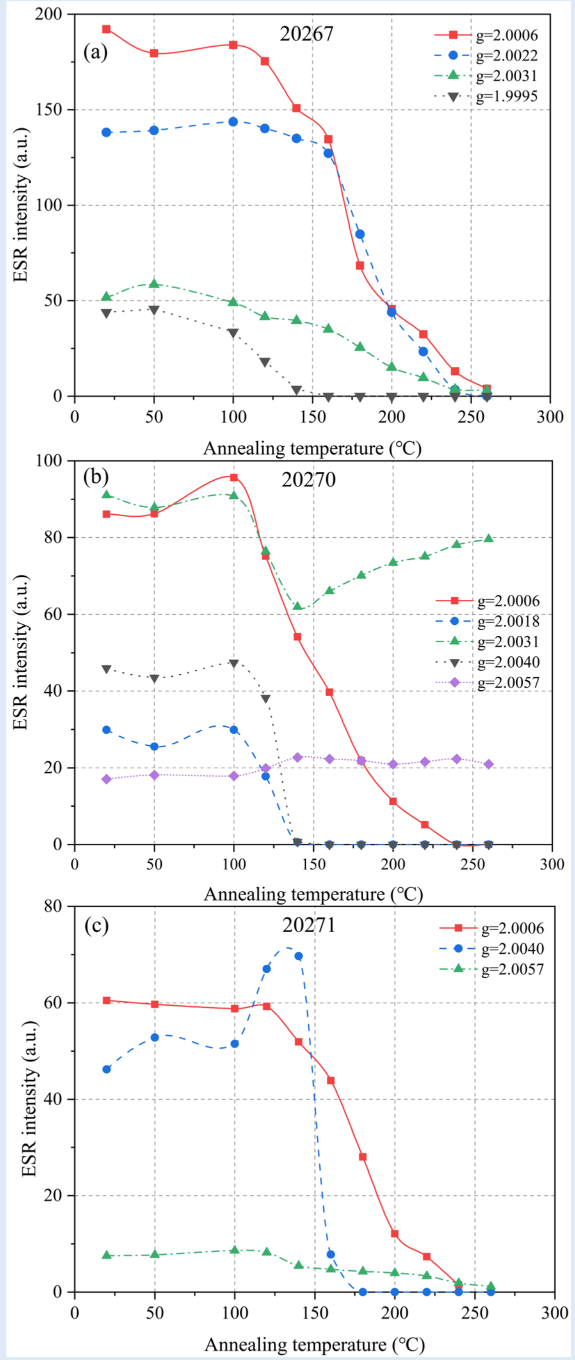

Fig. 3 Effect of isochron annealing experiments of 15 min on ESR signals for three terrestrial carbonates.

4. Conclusions

- The g=1.9995, g=2.0040, and g=2.0057 can be fully bleached by sunlight.
- The thermal behavior of the main ESR signals observed in terrestrial carbonates slightly changes with the origin.