**Table S1** The elemental compositions (%) of the marmatite and bornite

| minerals | Fe    | Zn    | S     | O     | Si   | Pb   | Cu   | Al   |
|----------|-------|-------|-------|-------|------|------|------|------|
| marmatite| 14.671| 48.282| 33.781| 2.223 | 0.581| 0.014| 0.002| 0.061|
| bornite  | 9.982 | 0.016 | 24.222| 2.528 | 0.555| 0.197| 62.301| 0.119|

| minerals | Cd   | Bi   | Mn   | In   | As   | Ca   |
|----------|------|------|------|------|------|------|
| marmatite| 0.008| 0.022| 0.101| 0.045| 0.207| /    |
| bornite  | /    | /    | /    | /    | /    | 0.053|

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Fig. S1 Standard Raman spectrum peak: (a) S, (b) CuS, (c) Bornite (Cu_5FeS_4S), (d) Cu_2S, (e) Sphalerite