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## Alteration, Order Degree and Geochemistry Features of Dolomites Associated with Zinc-Lead Mineralization in Maoping Pb- Zn Deposit, NE Yunnan, China

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Mississippi Valley type (MVT) lead-zinc sulfide deposits are commonly hosted in carbonate rocks, generally dolostone (e.g., Beanes, 1975; Leach, 2005; Graham and Langhorne, 2006). For much of the known MVT mineralization in the United States, the definitive spatial relationship between the margins and the alteration zones of dolomitization has been noted (Davis, 1977; Fulweiler and McDougal, 1971; McCormick et al., 1971; DeVoto, 1983; Hitzman, 1995; Hitzman et al., 1998; Gregg et al., 2001). Although field observations (summarized in Graham and Langhorne, 2006) and other studies (e.g., Maria et al., 1982; Ohle, 1985; Sangster, 1988; Smith, 2006) have revealed a common lithological sequence according to the major mineral phases and texture for most MVT deposits and their country rocks: host limestone → partially dolomitized limestone → dolomite consisting of void-filling saddle dolomite → sulfide ore-body (consisting of sulfides and saddle dolomite), there is no detailed mineralogical study of dolomite (Dol) in different lithological sequence, for example, the order degree, geochemistry composition, growth zones and isotope composition etc. That is, the relationship between mineralization and dolomitization still lacks microcosmic evidences. Therefore, in this paper, based on the three-dimensional alteration- lithofacies mapping, detailed order degree and geochemistry composition of Dol crystal in dolomitization dolostone of No.II ore-body and its hosted carbonate rocks in the Maoping lead-zinc deposit, northeastern Yunnan province, China has been studied. Our objective is to provide some microcosmic and more detailed microcosmic evidences for dolomitization associated with the mineralization in MVT deposit.

### 1 Geological Background

More than 400 lead-zinc deposits, which roughly define

the Sichuan-Yunnan-Guizhou (SYG) lead-zinc metallogenic belt (Liu and Lin, 1997), have been discovered in a large triangle-shaped region along the western margin of the Yangtze Platform. Most lead-zinc deposits of this belt display features that are diagnostic of typical MVT-type deposits (Zhang et al, 2005; Han et al., 2007; Huang et al., 2010; Wei et al., 2012; Zhou et al., 2013).

The Maoping lead-zinc deposit is located in northeast segment of the SYG lead-zinc belt (Liu and Lin, 1999 ). The mining district composes of Devonian to Permian bioclastics (limestone and dolostone) interlayered with sandstone and shale. Three major orebodies (group) have been explored within the ore field. The orebodies (group) are located at jointed regions of the NE- striking faults in the NW limb of the Shimenkan reversal anticline, and the bioclastic beds of Zaige, Baizuo, and Weining Formation are the ore-hosted rocks respectively. Numerous orebodies scatter throughout the ore field with highly variable shapes, such as vein, chamber, plat column, and statiform.

### 2 Mapping Results

On the basis of detail tunnel and borehole observations checked by thin-section examination, several mineralization belts can be identified for an orebody. Outward from center, they are massive Sp-Gn-Py ore, massive Py shell, disseminated-vein-patchy Sp-Gn-Py ore and star-shaped Py shell (Wei et al., 2012).

Alteration mapping demonstrated that the wall-rock alteration including dolomitization, calcitization, silicification, and argillation took place widespread in the ore field. We made a detail case study on the dolomitization associated with the ore-bodies hosting in the Carboniferous *Weining* Formation limestone (No.II ore-body). Field observations and thin-section examinations have demonstrated that the degree of dolomitization is exhibited by the change in grayness of

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limestone. The white sparry dolomite resulted from the highest degree dolomitization and light-gray carbonate rocks resulted from a higher degree dolomitization than that of grey rocks, while the dark grey rocks were not altered.

Synthesizing our observations of the hosted rocks, wall-rock alteration, and ore-bodies below lithofacies sequence appears: unaltered limestone (UL), leached limestone (LL), light grey dolostone (LGD), grey dolostone (GD), vein-like ore hosted gray and/or light gray dolostone (VHGD/VHLGD), massive pyrite hosted gray dolostone (MPGD), and massive ore with white sparry dolomite (MOSD). The last lithofacies represents the ore-body center of this sequence. Petrographic observations shows that there is no Dol in UL and the Dols in LL and MPGD have the same features with Dols in GD and in MOSD respectively. Thus the following study focus on the Dol in LGD, GD, VHGD, MOSD.

### 3 Order Degree and Geochemistry Features of Dolomites

Based on X-ray diffraction analysis of dolomitization dolostone collected from the different lithofacies sequence, the order degree of Dol (ODD) value are obtained. The Dol crystals in different sequence have relatively higher ODD value, and the ODD value decreases from outboard to the center of the orebodies.

Based on electron microprobe (EMP) analysis of Dol in different lithofacies sequence, some elements value of Dol crystals are obtained. The content of cations in this paper refers to mole percent. The average content of  $\text{Ca}^{2+}$  in Dol crystals in different lithofacies sequence is positive to the distance of lithofacies sequence to orebodies, except that MOSD has the lowest  $\text{Ca}^{2+}$  content. Whereas, the average content of  $\text{Mg}^{2+}$ ,  $\text{Ge}^{2+}$  and  $\text{Ba}^{2+}$  in Dol crystals in different lithofacies sequence is negative to the distance of lithofacies sequence to orebodies. The average content of  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Pb}^{2+}$  and  $\text{Co}^{2+}$  in Dol crystals is positive to the distance of lithofacies sequence to orebodies, and the average content of  $\text{Cu}^{2+}$ ,  $\text{Ga}^{3+}$  and  $\text{In}^{3+}$  in Dol crystals in different lithofacies sequence is none of the business with the distance of lithofacies sequence to orebodies. The value of  $\sum 100(\text{Fe} + \text{Mn} + \text{Zn} + \text{Pb}) / \sum (\text{Mg} + \text{Fe} + \text{Mn} + \text{Zn} + \text{Pb})$  increases from the outboard to the center of the orebody.

Moreover, the diagrams of the relationship between ODD and cations content in Dol crystals show that, the ODD is positive to the average content of  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  and  $\text{Ba}^{2+}$ , and is negative to the average content of  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Co}^{2+}$ , and none of the business with the average content of  $\text{Ge}^{2+}$ ,  $\text{Ga}^{3+}$  and  $\text{In}^{3+}$ .

### 4 Discussion and Conclusion

Mineralization-alteration mapping results indicate that dolomitization belt develop around a massive sulfide ore-bodies and exhibit a wide halos.

The ODD of Dol crystals mainly depends on crystal defect resulted from  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  arranging orderly or not, and other cations adding into the lattice or not (Fuchtbauer, 1974). Therefore, combining the results of the relationship between the element content in Dol and distance, and the results of the relationship between the ODD and cations content in Dol crystals, it can be conclude that some  $\text{Mg}^{2+}$  were substituted by a certain amount of  $\text{Fe}^{2+}$  and  $\text{Mn}^{2+}$  with minor  $\text{Zn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Co}^{2+}$  in isomorphous form, and  $\text{Ge}^{2+}$ ,  $2\text{Ga}^{3+}$  and  $2\text{In}^{3+}$  maybe not occur in the Dol lattice. This is the main reason for ODD varying with the distance of lithofacies sequence to orebodies. The value of  $\sum 100(\text{Fe} + \text{Mn} + \text{Zn} + \text{Pb}) / \sum (\text{Mg} + \text{Fe} + \text{Mn} + \text{Zn} + \text{Pb})$  refers to the content of substitution and its variation with the distance of lithofacies sequence to orebodies, which imply that dolomitization- forming fluid and sulfide ore-forming fluid are the evolutionary result of an united fluid system. And the  $\sum 100(\text{Fe} + \text{Mn} + \text{Zn} + \text{Pb}) / \sum (\text{Mg} + \text{Fe} + \text{Mn} + \text{Zn} + \text{Pb})$  value of Dol crystals can be used for guiding the ore exploration.

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