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Research Advances

New Geochronologic Evidence of Diabases and Their Metallogenic Relationship with the Makeng-Type Iron Deposits in Southwest Fujian, SE China

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Objective

The Makeng-type iron deposits are located in Late Paleozoic depression of southwest Fujian Province in the southeast edge of Cathaysia, which are famous for their huge scale and specific ore genesis. Previous studies mainly focus on the ore characteristics, metallogenic setting and the granites in the mining area, and there is still controversy on the ore genesis. Recent research has revealed that the iron ore bodies are spatially closely related to diabase rocks, especially those in the Makeng Fe deposit. Diabase dykes are widely distributed in the Makeng, Luoyang, Zhangkeng and other iron deposits, but they are little documented about their diabase rocks and their relationship with the mineralization, which has hindered the understanding about the genesis of Makeng-type iron deposits. This study conducted a new geochronologic study on diabase rocks in the Makeng-type iron mine areas to provide new constraints on ore genesis and metallogenic age of Makeng-type iron deposits in southwest Fujian Province.

Methods

Zircon grains were obtained by a combination of standard heavy liquid and magnetic separation techniques at the laboratory of the Institute of Regional Geology and Mineral Resources Survey of Hebei Province. The zircons were mounted onto an epoxy resin disk, polished to about half of the zircon model grain thickness, and were documented with both reflected and transmitted light micrographs. Prior to U-Pb isotopic analysis, the internal structures of the zircons were imaged by cathodoluminescence (CL) techniques at the Beijing SHRIMP Centre. Analyses of the zircons were carried out using a laser ablation inductively coupled plasma mass spectrometer (LA–ICP–MS) at the Geological Lab Center of the Tianjin Institute of Geology and Mineral Resources. Weighted mean U-Pb ages and concordia plots were processed using ISOPLOT 3.0, with uncertainties quoted at 1σ and 95% confidence levels.

Results

Systematic zircon U-Pb dating was carried out to provide more constraints on the ore-forming time and ore-genesis of Makeng-type iron deposits. In this research, four diabase samples were collected from the Makeng (samples No. b228 and b3097), Zhangkeng (sample No. MK03) and Luoyang (sample No. SHK1103) iron ore deposits (Fig. 1). These diabase rocks were close to the magnetite ore bodies in space. The zircon grains separated from the basic dykes are euhedral crystals, showing clear oscillatory zoning without obvious core-mantle structure. The morphological characteristics, magmatic oscillatory zonings of the zircon grains and high Th/U ratios (>0.1) indicate that these diabase rocks are of a magmatic origin. On the whole, the $^{206}U/^{238}Pb$ and $^{207}U/^{235}Pb$ ages of these zircons of each sample are concordant, showing concentrated tufted shapes with U-Pb data clustering near the concordia lines (Fig. 1). Twelve and seven analyses of representative diabase samples from the Makeng iron deposit yield weighted mean $^{206}Pb/^{238}U$ ages of 146.5±1.9 Ma (sample No. b228) and 141±1 Ma (sample No. b3097), respectively (Table 1). Twenty-one and 11 analyses from the Zhangkeng and Luoyang iron deposits yield weighted mean $^{206}Pb/^{238}U$ ages of 152.7±1.4 Ma (sample No. MK03) and 139.5±1.3 Ma (sample No. SHK1103), respectively (Appendix 1). U-Pb dating results suggest that these diabase rocks were formed in the Late Jurassic to Early Cretaceous.

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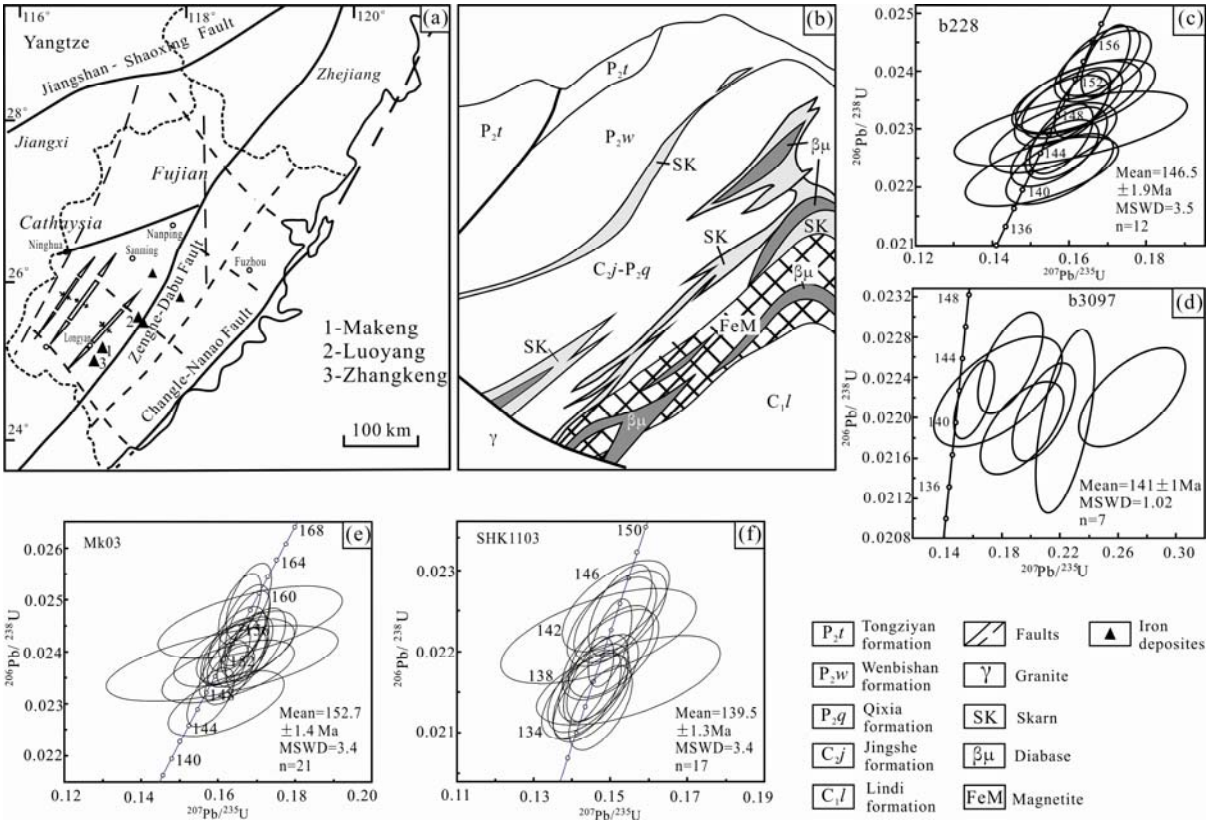

Fig. 1. Maps showing tectonic setting (a) and geology (b) of the Makeng iron deposit, and zircon U-Pb concordia diagrams of diabase rocks in the Makeng (c and d), Zhangkeng (e) and Luoyang (f) deposits.

Conclusions

Diabase dykes are widely spread and are spatially close to the magnetite ore bodies in the Makeng, Luoyang and Zhangkeng iron deposits. Zircons picked out from these diabase rocks show oscillatory zoning with high Th/U ratios, indicating their magmatic genesis. Four representative diabase samples collected from the Makeng, Luoyang and Zhangkeng iron deposits yield weighted mean $^{206}Pb/^{238}U$ ages of 146.5±1.9 Ma, 141±1 Ma, 152.7±1.4 Ma and 139.5±1.3 Ma, respectively, indicating that these diabase rocks were formed during the Late Jurassic to Early Cretaceous.

The Makeng deposit exhibited obvious alteration zoning around diabase dykes, which displays widespread alteration zoning of diabase–altered diabase–skarn–magnetite from the centre to the edge of diabase dykes. These features show a concomitant relationship between the diabase rocks and mineralization, and these rocks possibly provide parts of iron source for the mineralization. Considering the close relationship between diabase rocks and the iron ore bodies in the mine areas, we consider that the U-Pb ages of diabase rocks can represent the ore-forming ages of the Makeng type iron deposits. Diabase rocks are usually thought to form in an extensional setting which is favorable for ore formation. In conclusion, we consider these diabase rocks are closely related to iron mineralization in the Makeng-type iron deposits, and these iron ores were formed during the Late Jurassic to Early Cretaceous (139–152 Ma).

Acknowledgements

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Appendix 1 LA-MC-ICPMS zircon U-Pb analytical results for diabase rocks from Makeng-type iron deposits in southwest Fujian

Spot	Th/U	Isotopic ratios						Age (Ma)					
		$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ
b228													
1	0.3034	0.0505	0.0038	0.1603	0.0124	0.0230	0.0003	220	176	151	12	147	2
2	0.8123	0.0504	0.0023	0.1636	0.0076	0.0236	0.0003	212	105	154	7	150	2
3	0.5641	0.0496	0.0016	0.1605	0.0053	0.0235	0.0002	178	75	151	5	149	2
4	0.6055	0.0495	0.0021	0.1558	0.0067	0.0228	0.0002	170	97	147	6	146	2
5	1.1457	0.0498	0.0026	0.1529	0.0081	0.0223	0.0002	184	122	144	8	142	2
6	0.3661	0.0491	0.0015	0.1579	0.0049	0.0233	0.0002	153	72	149	5	149	2
7	0.3169	0.0501	0.0010	0.1578	0.0034	0.0228	0.0002	201	48	149	3	146	2
8	0.3816	0.0506	0.0009	0.1633	0.0030	0.0234	0.0002	220	39	154	3	149	2
9	0.4948	0.0500	0.0020	0.1623	0.0067	0.0235	0.0003	194	93	153	6	150	2
10	0.2339	0.0512	0.0018	0.1575	0.0057	0.0223	0.0002	249	79	148	5	142	2
11	0.1293	0.0507	0.0013	0.1592	0.0044	0.0228	0.0003	228	61	150	4	145	2
12	1.0222	0.0501	0.0015	0.1562	0.0047	0.0226	0.0002	202	68	147	4	144	1
b3097													
1	0.8435	0.0577	0.0065	0.1771	0.0203	0.0223	0.0002	519	222	166	17	142	1
2	0.9728	0.0599	0.005	0.1861	0.0164	0.0225	0.0002	598	102	173	9	144	1
3	1.0166	0.0639	0.0048	0.1929	0.0149	0.0219	0.0002	738	126	179	11	140	1
4	1.2592	0.0685	0.0046	0.2084	0.0147	0.0221	0.0002	885	85	192	8	141	1
5	0.9196	0.0881	0.0049	0.2697	0.0150	0.0222	0.0002	1385	106	242	13	142	1
6	0.9625	0.0524	0.0016	0.1602	0.0055	0.0222	0.0002	303	74	151	5	141	1
7	6.3522	0.0739	0.0066	0.2236	0.0232	0.0220	0.0004	1037	67	205	8	140	2
MK03													
1	0.4137	0.0491	0.0007	0.1622	0.0025	0.0240	0.0002	154	31	153	2	153	1
2	0.6006	0.0500	0.0009	0.1648	0.0031	0.0239	0.0002	194	43	155	3	152	1
3	0.6172	0.0484	0.0006	0.1656	0.0023	0.0248	0.0003	117	30	156	2	158	2
4	0.4513	0.0488	0.0006	0.1680	0.0024	0.0250	0.0003	137	27	158	2	159	2
5	0.9010	0.0509	0.0007	0.1696	0.0032	0.0241	0.0003	238	34	159	3	154	2
6	0.5279	0.0504	0.0013	0.1674	0.0053	0.0241	0.0003	213	61	157	5	153	2
7	0.1201	0.0506	0.0006	0.1676	0.0023	0.0240	0.0003	222	28	157	2	153	2
8	0.4297	0.0505	0.0007	0.1664	0.0027	0.0239	0.0002	217	33	156	3	152	2
9	0.8989	0.0504	0.0007	0.1675	0.0028	0.0241	0.0002	213	34	157	3	154	2
10	0.8355	0.0493	0.0009	0.1631	0.0031	0.0240	0.0003	161	41	153	3	153	2
11	0.1905	0.0493	0.0006	0.1668	0.0027	0.0245	0.0003	164	27	157	3	156	2
12	0.7286	0.0495	0.0007	0.1580	0.0025	0.0231	0.0002	174	35	149	2	147	1
13	0.7472	0.0491	0.0041	0.1610	0.0123	0.0238	0.0003	153	197	152	12	152	2
14	0.6038	0.0496	0.0020	0.1641	0.0064	0.0240	0.0003	177	93	154	6	153	2
15	0.3169	0.0502	0.0008	0.1630	0.0026	0.0236	0.0002	203	35	153	2	150	1
16	0.4870	0.0495	0.0007	0.1614	0.0026	0.0237	0.0002	171	35	152	2	151	1
17	0.5136	0.0511	0.0018	0.1621	0.0062	0.0230	0.0003	245	83	153	6	147	2
18	0.6243	0.0497	0.0029	0.1683	0.0098	0.0246	0.0003	180	135	158	9	157	2
19	0.5425	0.0493	0.0008	0.1649	0.0030	0.0243	0.0003	163	38	155	3	155	2
20	0.5976	0.0496	0.0006	0.1677	0.0024	0.0245	0.0003	178	29	157	2	156	2
21	2.0882	0.0499	0.0022	0.1626	0.0071	0.0236	0.0002	190	102	153	7	151	2
SHK1103													
1	0.6556	0.0491	0.0010	0.1525	0.0034	0.0225	0.0002	154	50	144	3	144	1
2	0.7011	0.0480	0.0033	0.1468	0.0104	0.0222	0.0002	98	164	139	10	142	2
3	1.1549	0.0486	0.0012	0.1439	0.0036	0.0215	0.0002	128	57	136	3	137	1
4	0.7345	0.0485	0.0014	0.1442	0.0043	0.0216	0.0002	125	69	137	4	137	1
5	1.4759	0.0491	0.0007	0.1498	0.0023	0.0221	0.0002	155	33	142	2	141	1
6	1.2757	0.0491	0.0014	0.1468	0.0042	0.0217	0.0002	154	66	139	4	138	1
7	0.8850	0.0490	0.0010	0.1466	0.0033	0.0217	0.0002	150	50	139	3	138	1
8	0.7407	0.0483	0.0008	0.1443	0.0027	0.0217	0.0002	116	41	137	3	138	1
9	1.3399	0.0487	0.0015	0.1503	0.0047	0.0224	0.0002	135	71	142	4	143	1
10	0.6060	0.0495	0.0014	0.1501	0.0045	0.0220	0.0002	170	68	142	4	140	1
11	0.9421	0.0502	0.0011	0.1474	0.0033	0.0213	0.0002	203	51	140	3	136	1
12	0.8704	0.0491	0.0013	0.1451	0.0041	0.0214	0.0002	154	63	138	4	137	1
13	0.8045	0.0484	0.0015	0.1433	0.0046	0.0215	0.0002	120	75	136	4	137	1
14	0.3169	0.0493	0.0016	0.1525	0.0049	0.0224	0.0002	162	74	144	5	143	1
15	0.9245	0.0486	0.0018	0.1513	0.0057	0.0226	0.0002	130	87	143	5	144	1
16	0.6776	0.0495	0.0017	0.1500	0.0051	0.0220	0.0002	173	79	142	5	140	1
17	0.0628	0.0518	0.0032	0.1546	0.0098	0.0217	0.0002	276	143	146	9	138	1