Table 2 Effects, levels, and sources of some trace elements in gray iron

Element	Trace level, %	Effects	Sources
Aluminum	≤0.03	Promotes hydrogen pinhole defects, especially when green sand molds are used and at levels above 0.005%. Neutralizes nitrogen	Deliberate addition, ferrous alloys, inoculants, scrap contaminated with aluminum components
Antimony	≤0.02	Promotes pearlite. Addition of 0.01% reduces the amount of ferrite sometimes found adjacent to cored surfaces	Vitreous enameled scrap, steel scrap, white metal bearing shells, deliberate addition
Arsenic	≤0.05	Promotes pearlite. Addition of 0.05% reduces the amount of ferrite sometimes found adjacent to cored surfaces	Pig iron, steel scrap
Bismuth	≤0.02	Promotes carbides and undesirable graphite forms that reduce tensile properties	Deliberate addition, bismuth-containing molds and core coatings
Boron	≤0.01	Promotes carbides, particularly in light-section parts. Effects become significant above about 0.001%	Deliberate addition, vitreous enameled scrap
Chromium	≤0.2	Promotes chill in thin sections	Alloy steel, chromium plate, some refined pig iron
Copper	≤0.3	Trace amounts have no significant effect and can be ignored	Copper wire, nonferrous alloys, steel scrap, some refined pig iron
Hydrogen	≤0.0004	Produces subsurface pinholes and (less often) fissures or gross blowing through a section. Mild chill promoter. Promotes inverse chill when insufficient manganese is present. Promotes coarse graphite	Damp refractories, mold materials, and additions
Lead	≤0.005	Results in Widmanstätten and "spiky" graphite, especially in heavy sections with high hydrogen. Can reduce tensile strength 50% at low levels (≥0.0004%). Promotes pearlite	Some vitreous enamels, paints, free-cutting steels, nonferrous alloys, terne plate, white metal, solder, some pig irons
Molybdenum	≤0.05	Promotes pearlite	Some refined pig iron, steel scrap
Nickel	≤0.01	Trace amounts have no major effect and can be ignored	Refined pig iron, steel scrap
Nitrogen	≤0.02	Compacts graphite and increases strength. Promotes pearlite. Increases chill. Can cause pinhole and fissure defects. Can be neutralized by aluminum or titanium	Coke, carburizers, mold and core binders, some ferroalloys, steel scrap
Tellurium	≤0.003	Not usually found, but a potent carbide former	Free-cutting brasses, mold and core coatings, deliberate addition
Tin	≤0.15	Strong pearlite promoter; sometimes deliberately added to promote pearlitic structures	Solder, steel scrap, nonferrous alloys, refined pig iron, deliberate addition
Titanium	≤0.15	Promotes undercooled graphite. Promotes hydrogen pinholing when aluminum is present. Combines with nitrogen to neutralize its effects	Some pig irons, steel scrap, some vitreous enamels and paints, deliberate addition
Tungsten	≤0.05	Promotes pearlite	Tool steel
Vanadium	≤0.08	Forms carbides; promotes pearlite	Steel scrap; some pig irons

Source: Ref 5

In cupola melting, nickel, copper, chromium, and molybdenum are added to the molten metal during or after tapping, rather than being added to the cupola charge. If the ladle that receives the molten metal at the spout will pour the castings without a transfer, the alloying metal may be added to the stream at the spout. This practice generally provides reasonably thorough mixing, although the exact amount of iron tapped into the receiving ladle is sometimes difficult to control. A more common practice is to add the alloying metals to the stream from the receiving ladle (or forehearth, if used) as it is transferred to the pouring ladle, because it may not be desirable to alloy all of the metal in the receiving ladle or forehearth. The amount of mixing obtained by adding to the stream is usually sufficient, although to obtain more thorough mixing the alloyed metal is sometimes poured from the transfer ladle to another transfer ladle.